# SUMMARY REPORT

OF THE

## MINES BRANCH

OF THE

# DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31

# 1909

*PRINTED BY ORDER OF PARLIAMENT*

OTTAWA
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EXCELLENT MAJESTY
1910

*To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G.C.M.G., &c., &c., &c., Governor General of Canada.*

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII., Chapter 29, section 18, the Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1909.

(Signed) W. TEMPLEMAN,
*Minister of Mines.*

Hon. Wm. Templeman,
Minister of Mines,
Ottawa.

Sir,—I have the honour to submit herewith, the Director's Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1909.

I am, sir, your obedient servant,

(Signed) A. P. LOW,
*Deputy Minister.*

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# SUMMARY REPORT

OF THE

# MINES BRANCH OF THE DEPARTMENT OF MINES

## FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1909

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A. P. Low, Esq., LL.D.,
Deputy Minister,
Department of Mines.

SIR,—I have the honour to submit, herewith, the Summary Report of the Mines Branch of the Department of Mines for the calendar year ending December 31, 1909.

## CHANGES IN STAFF.

By Order-in-Council, dated June 2, 1909, Mr. W. W. Leach, technical officer of the Mines Branch, was re-transferred to the Geological Survey Branch.

Erik Nyström, technical officer, resigned March 31, 1909, to accept the position of Consulting Engineer to the Jern-kontorets, of Stockholm, Sweden; and on May 1, 1909, Dr. Alfred W. G. Wilson was appointed to fill the vacancy.

## PROGRESS IN ELECTRO-METALLURGY.

### ELECTRIC FURNACES FOR IRON ORE SMELTING AND STEEL MANUFACTURE.

The extraordinary rapidity with which electric furnaces for the production of steel have been developed and perfected since the publication of the Report[1] of the Commission appointed by the Dominion Government to investigate the Electro-thermic processes in Europe in 1904, will be appreciated when it is stated that only four electric furnaces of comparatively small capacity were then in existence in Europe; whereas in 1908—four years later—there were forty-six in operation, and thirty-one under construction.

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[1]Report of the Commission appointed to investigate the different Electro-Thermic Processes for the smelting of Iron Ores and the making of Steel, in operation in Europe. Mines Branch, Department of Mines, 1904.

The well-known technical journal *Stahl und Eisen*, Vol. XXVIII. 1908, gives the following tabulation of electric furnaces erected or in course of construction:—

PRESENT STATUS OF ELECTRIC STEEL INDUSTRY.

| Works. | Charge. | Currents. | Size. |
|---|---|---|---|
| INDUCTION FURNACES. | Kilograms. | | Kilowatts. |
| *Kjellin.* | | | |
| Röchling Iron and Steel Works, Völklingen (Germany) | 8 500 | Single-phase | 750 |
| Fried. Krupp, A.-G., Essen (Germany) | 8,500 | " | 750 |
| Oberschlesische Eisenindustrie—A. G., Gleiwitz (Germany) | 1,500 | " | 180 |
| Poldhütte, Kladno (Bohemia) | 4,000 | " | 440 |
| J. Brauns' Söhne, Vöcklabruck (Austria) | 400 | " | 65 |
| Allg. Calcium carbide-Genossenschaft Gurtnellen (Switzerland) | ........ | " | 330 |
| Vidua de Urigoitia è Hijà Araya (Spain) | 1,500 | " | 215 |
| Alti Forni Gregorini, Lovere (Italy) | 1,500 | " | 330 |
| Eisenwerk Domnarfvet, Gysinge (Sweden) | 1,500 | " | 175 |
| Metallurgiska Aktiebolaget, Trollhättan (Sweden) | 2,000 | " | 330 |
| Vickers, Sons, & Maxim, Sheffield | 550 | " | 150 |
| Gröndal-Kjellin Co., Nine Elms Lane (London) | 100 | " | 60 |
| American Electric Furnace Co., Niagara Falls (U.S.A.) | 800 | " | 150 |
| " " " | 100 | " | 60 |
| *Röchling-Rodenhauser.* | | | |
| Röchling Iron and Steel Works, Völklingen (Germany) | 3,500 | " | 400 |
| " " " | 8,500 | " | 750 |
| " " " | 2,000 | 3-phase | 275 |
| Bergische Stahlindustrie, Remscheid (Germany) | 5,000 | Single-phase | 500 |
| Le Gallais, Metz, & Co., Dommeldingen (Luxembourg) | 700 | " | 100 |
| " " " | 3,500 | " | 300 |
| " " " | ........ | " | 300 |
| " " " | 1,500 | 3-phase | 275 |
| Aciéries Liégoises, Bressoux-les-Liège (Belgium) | 1,000 | " | 200 |
| J. Knöpfel, Walzenhausen (Switzerland) | 1,000 | " | 175 |
| *Schneider.* | | | |
| Schneider & Co., Creusot (France) | 1,000 | " | Experimental. |
| *Schneider-Gin.* | | | |
| Plettenberg (Germany) | 4,500 | Single-phase | 400 |
| *Colby.* | | | |
| H. Disston & Sons, Philadelphia (U.S.A.) | 90 | " | |
| *Frick.* | | | |
| Fried. Krupp, A.-G., Essen (Germany) | 10,000 | ........ | 750 |
| John Brown & Co., Sheffield | 1,800 | ........ | 200 |
| Wm. Jessop & Sons, Sheffield | 3,000 | ........ | 450 |
| *A.-G. Electrometall, Ludvika (Sweden.)* | | | |
| Arvika (Sweden) | 1,000 | 3-phase | 175 |
| Hagfors (Sweden) | 500 | " | 125 |
| St. John del Rey Mining Co. (Brazil) | 2,000 | " | 300 |
| ARC FURNACES. | | | |
| *Héroult.* | | | |
| Edgar Allen & Co., Sheffield | 3,000 | Single-phase | |
| Stahlwerke Richard Lindenberg A.-G., Remscheid-Hasten, (Germany) | 3,000 | " | 370 |
| " " " | 1,800 | " | 300 |
| " " " | 500 | " | |

PRESENT STATUS OF ELECTRIC STEEL INDUSTRY—*Continued.*

| Works. | Charge. | Currents. | Size. |
|---|---|---|---|
| ARC FURNACES—*Con.* | Kilograms. | | Kilowatts. |
| *Héroult*—Con. | | | |
| Bismarckhütte, Bismarckhütte (Germany) | 3,000 | " | 400 |
| " " | 1,000 | " | 260 |
| Deutsch-Oesterreichische Mannesmann-Röhren-Werke, Burbach (Germany) | 3,000 | " | 400 |
| Deutsche-Mannesmann-Röhren-Werke, Saarbrücken (Germany) | ........ | " | |
| Danner & Co., Judenburg (Austria) | 2,000 | " | 300 |
| Gebr. Böhler & Cie., A. G., Kapfenberg (Austria) | 2,500 | " | 350 |
| Georg. Fischer, Schaffhausen (Switzerland) | 1,000 | " | 250 |
| " " " | 5,000 | " | 250 |
| " " " | 5,000 | " | 250 |
| Kaernthner Eisen & Stahl Werke (Austria) | 5,000 | " | 765 |
| Soc. Electromét Française, La Praz (France) | 3,000 | " | 370 |
| Acièries du Saut du Tarn, St. Juéry (France) | 5,000 | " | 600 |
| Aktiebolaget Héroults Electriska Stal, Kortfors (Sweden) | 4,500 | Single-phase | 300 |
| Halcomb & Co., Syracuse (U.S.A.) | 5,000 | " | |
| The Noble Electric Co., Baird (U.S.A.) | 5,000 | " | |
| The Firth Sterling Steel Co., McKeesport (U.S.A.) | 10,000 | " | |
| Società Tubi Mannesmann, Dalmine (Italy) | 6,000 | " | 736 |
| " " | 6,000 | " | 736 |
| *Du Giffre.* | | | |
| Soc. des Hauts-fourneaux et Forges, Allevard (France) | 3,200 | " | 500 |
| *Girod.* | | | |
| S. A. Electrométallurg. Procédés P. Girod, Ungine (France) | 1,800 | " | 300 |
| " " | 2,000 | " | 300 |
| " " | 2,000 | " | 300 |
| " " | 8 to 10,000 | " | 1,200 kw., 4 electrodes. |
| " " | 8 to 10,000 | " | 1,200 kw., 4 electrodes. |
| Oehler & Co., Aarau (Switzerland) | 2,000 | " | 300 |
| John Cockerill, Seraing (Belgium) | 3 to 4,000 | " | 450 |
| A. Stotz, Stuttgard-Kornwestheim (Germany) | 2,000 | " | 300 |
| Marrel Frères, Rive de Gier (France) | ........ | " | |
| Ternitzer Eisen-und Stahlwerke, Ternitz (Austria) | ........ | " | |
| *Stassano.* | | | |
| Bonner Fräserfabrik, G. m. b. H. Bonn (Germany) | 1,000 | 3-phase | 185 |
| " " | 1,000 | " | 185 |
| Forni Termoelettrici Stassano, Turin (Italy) | 5,000 | " | 750 |
| " " | 5,000 | " | 750 |
| " " | 900 | " | 180 |
| " " | 900 | " | 180 |
| " " | 900 | " | 80 |
| " " | 400 | Single-phase | 75 |
| " " | 400 | " | 75 |
| Royal Arsenal, Turin (Italy) | 700 | 3-phase | 150 |
| " " | 700 | " | 150 |
| *Keller.* | | | |
| Holtzer & Co., Unieux (France) | 8,000 | | |

Since 1904 a number of furnaces of the Héroult type—the resistance type of furnace—have been installed in the United States of America.

The development of the electric furnace for the production of pig iron has proceeded much more slowly, and it is only within the last eighteen months that a commercial furnace has been constructed and perfected by the Aktiebolaget Electro-Metall, Ludvika, Sweden. At the present time a 2,500 horse-power electric shaft furnace of this type is under construction at Trollhätten, under the auspices of the Jern-kontorets, of Sweden.

The impression has been created by news items which have appeared in European journals that the experimental stage in the electric smelting of iron ores has not yet been passed, and that the last mentioned furnace being erected by the Jern-kontorets is intended for further experimentation. The latest informaton relative to that furnace is announced in the *Affarsvarlden: Economiskveckorevv,* No. 77, November 25, 1909. RD 1425-6, as follows:—

### Electric Iron Smelting.[1]

> In consequence of the purchase made by the Iron-Office, of the Swedish patent that belonged to the Elektro Metal Company, Limited, and the plan of building electric furnaces at Trollhätten, as mentioned before in this paper, it has been represented in the press, and especially in German papers, as if it was meant to be an experimental furnace by which it should be ascertained whether the electric smelting process would prove to be practically and economically possible, or as if here was a question of first attempts. This is, however, not the case, for at the Domnarfvet iron works an electric machine of 700 h.p. on the 'Electrometal' principle has been in constant operation for some length of time, and from Mr. Yngstrom's report in 'the annals of the Iron-Office' it will be clearly seen that the problem of producing iron by electricity is solved practically as well as economically. The furnace that the Iron-Office resolved upon building should, therefore, not be considered as an experimental furnace, but as a plant to which any owner of iron works or mines may bring his ore for smelting and get it ascertained what quality of iron he will gain by the electric smelting method. Undoubtedly discoveries will at the same time be made in order to find out what further advantages the electric smelting process may have, compared with that of the coke furnace.

Advices received at the Mines Branch office show that the firm of Jens Orten Boving & Co., 9½ Union Court, Old Broad street, London, England, have acquired the patent rights for Mexico, United States, and Canada of the electric furnace (Domnarfvet resistance type) invented by the Aktiebolaget Electro-Metall, Ludvika, Sweden.

## ELECTRIC FURNACES FOR THE REDUCTION OF SPELTER AND ZINC OXIDE.

### SPELTER FURNACES.

In the Summary Report for 1908 I mentioned two electro-thermic processes for the production of spelter: namely, the plant at Trollhätten, Sweden, and the demonstration plant now being erected in London, England—both of which were invented by Dr. De Laval; but which differ in principle and in construction. Particulars have since been received describing a third process (invented by Messrs. Côte and Pierron,

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[1] The English is that of the Journal.

France), which, it is claimed, is of special economic advantage in dealing with composite zinc-lead ores, since it effects a practically complete separation of the zinc from the lead. These processes are to be investigated, and the results, together with illustrated descriptions of the processes, published in a separate bulletin.

## BISULPHITE PROCESS FOR THE TREATMENT OF REFRACTORY ZINC-LEAD-SILVER ORES, Etc.

On page 7 of my last report, reference was made to the chemical process invented by Messrs. Sulman and Picard, metallurgical chemists and assayers, 44 London Wall, London, England, and Dr. Hommel, for the treatment of zinc-lead-silver ores, etc., by means of which, it is claimed, all the zinc, lead, and silver in the ores can be saved.

A description of the process is in the possession of the Mines Branch; but until the experiments now being conducted in Swansea, South Wales, Great Britain, are completed, no public disclosure is permitted. Arrangements have been made, however, for the investigation of this chemical process and the subsequent publication of a report on its commercial feasibility.

### AIR NITRATES BY ELECTRICITY.

In my Summary Report for 1907-8, reference was made to the experiments conducted in France by Müntz and Lainé in the production of nitre by the intensified nitrification of peat beds; for use in the manufacture of explosives and war ammunition. Further reference was also made to the approaching exhaustion of the Chilian nitrate beds, and to the advantages of establishing a nitrates industry in Canada; not only in the interests of agriculture—for the supply of fertilizers; but for the utilization of saltpetre in the manufacture of explosives. Since the publication of the foregoing suggestions, considerable progress has been made towards perfecting the process for producing nitrous oxide direct from the air by means of electricity. It has been demonstrated that wherever electric energy can be produced at about $4 to $5 per electric horse-power year, atmospheric nitrogen can be transformed economically into nitrates.

The following extract from the U.S.A. *Daily Consular and Trade Report,* January 19, 1910, shows that the Norwegians are fully alive to the resources of their country, and with commendable energy and enterprise are utilizing them to advantage:—

### NITRATES IN NORWAY.

*Erection of Large Works for its Manufacture in the Kingdom.*

Supplementing previous articles in *Consular and Trade Reports* on the manufacture of air nitrates for fertilizer in Norway, Germany, and Niagara Falls, Canada, it is learned from British consular reports that the industry is undergoing rapid expansion in the first-named country, where nearly $15,000,000 will be invested. Though there are vast water-powers in the United States running to waste, which could be utilized to produce this article, nothing has yet been done in that line, although this country is buying annually $15.000,000 worth of Chilian nitrates. The British consul's report from Christiania reads:—

Up till now about $6,000,000 has been expended on the works at Notodden and Svaelgfos and the power stations under construction at Rjukan and Vamma. When all the works are completed, at the end of 1910, $14,600,000 will have been spent. A great point in connection with the development of this industry, is that the opportunity has now arisen of opening up several industries in connection with the manufacture of nitrates, such as nitric acid, nitrate of ammonia, nitrate of potash, also sodium nitrate, which last is already being manufactured.

The Nobel syndicate, in conjunction with the Birkeland and Eyde Company, is now concentrating the weak acids, with the assistance of the gas furnaces, to an acid of such percentage as to become an article of transport, and further opportunities have thus been opened for export trade, especially from works with water-power that are situated near the seaboard.

It is of interest to note that no coal is used in the production of saltpetre or other products here referred to. It is stated authoritatively that there is no probability for many years to come that the sale of saltpetre produced by the method practiced at the Notodden and Rjukanfos works will be disturbed by competition with Chili saltpetre on the question of price.

### LARGE ANNUAL PRODUCTION.

When the Rjukan Falls works are fully completed, they and the Notodden works combined will represent 240,000 horse-power, with a production of saltpetre representing an export value of $6,164,000.

At some not very far distant time it is not improbable that the waterways and loughs between Skien and Notodden may be increased to such size as to allow sea-going vessels to load up at Notodden. Plans have already been worked out and are under consideration in connection therewith. At present everything has to be lightered to and from Skien.

The value of the output of nitrates in Norway in 1908, was about $536,000, and the total expenses amounted to $402,000.

The following are the companies that are producing, or will shortly produce, saltpetre from the air:—

(1) The North Hydro Elektrisk Kvaelstof Aktieselskab, Christiania, who are the owners of Notodden Saltpeterfabrikker, the power of which (35,000 h.p.) is supplied from the Svaelgfos. The capital of the company, which is French, is $7,890,000.

(2) The Vammafos (Vamma Falls) Company, whose saltpetre works are now under construction. This company is a separate company, but half of its shares are said to be owned by the Norsk Hydro Elektrisk Kvaelst of Aktieselskab; some of the preference shares are in the hands of Norwegians. The amount of capital can not be stated.

(3) Rjukanfos (Rfukan Falls) Company, whose saltpetre works are also in course of erection. The capital of the company, which is one-half French and the other half Scandinavian and German, is $3,376,800. This capital has been furnished by some of the shareholders of the Norsk Hydro Elektrisk Kvaelst of Aktieselskab and of the Kraft Aktieselskab, but the company is an independent one.

(4) The Mater and Tyin waterfalls are owned by the Norsk Hydro Elektrisk Kvaelstof Aktieselskab and by the Kraft Aktieselskab, but the companies formed in connection with these falls are two separate companies with separate administrations. Electro-technical works will probably be erected at both of these falls.

(5) Khristianssands Elektrokemiske Aktieselskab, which is the property of the Badische Anilin und Soda Fabrik, Ludwigshafen, and has a capital of $53,600.

## PLEA FOR A CANADIAN NITRATES INDUSTRY.

Canada imported only $698,608 worth of nitrate of soda in 1908; whereas the United States imports about $15,000,000 worth of Chilian nitrates annually to refertilize her exhausted agricultural lands. The reason for the comparative smallness of Canada's import trade in nitrates is explained by the fact that the prairie lands of the Dominion are covered with rich virgin soil, hence do not need replenishing with artificial fertilizers to any serious extent. In a few years, however, the law of diminishing returns will apply to Canada as seriously as it does to the United States. When that time arrives, nitrates will be greatly in demand in the agricultural regions of this country.

The farseeing nations of northwestern Europe are evidently preparing for a large export trade in artificial fertilizers, as the foregoing extracts from the British consular report shows. Perceiving that the guano beds of Peru, and the saltpetre beds of Chili are rapidly approaching exhaustion, they are straining every nerve to establish an immense nitrates industry.

But seeing that this country is almost prodigally furnished by nature with water-powers, from which electric energy can be developed at reasonable rates, there is no reason why a flourishing industry in the manufacture of air nitrates should not be established for supplying not only our own home market, but also the markets of the United States and the Orient.

## ACCIDENTS IN MINES CAUSED BY EXPLOSIVES.

The number of accidents in mines and in other places where explosives are used has been increasing at an alarming rate in recent years. These accidents are due in part to a lack of knowledge of the nature and use of explosives and in part probably to defective manufacture. Early in 1909, steps were taken to gather comparative data and statistics for the purpose of studying the situation thoroughly. The first memorandum on the subject is dated June 27, 1909.

Only a brief epitome of the information collected can be given at this stage[1], but what is submitted will serve to show the serious need of a stringent code of laws regulating the sale and use of explosives.

### *Great Britain.*

For a number of years the British government has carried on at Woolwich—under the Explosives Act of 1875 and amendments—investigations relative to the manufacture and use of explosives. Under this Act only explosives specified as 'Authorized' are allowed to be used in the United Kingdom. The expression 'authorized explosive' means exclusively an explosive defined in a list of authorized explosives signed by a government inspector and in force for the time being.

No manufacturer of powder or other explosive is allowed to sell, or put on the market any explosive which has not been tested in the Government station. The manufacturer has to submit both the final product and the component parts of all explosives for chemical and physical analysis.

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[1] See Preliminary Report of J. G. S. Hudson.

The Government issues a printed list of all 'Permitted' explosives, together with the rules and regulations for their use. These regulations are rigidly enforced and no evasion is allowed. As a result of this wise provision, accidents due to the use of dynamite and other high explosives used in mining and blasting operations, have been greatly reduced.

During the year 1906, in one of the large English mining districts, not a single accident from explosives, or shot-firing was reported; in spite of the fact that 29 different kinds of explosives were used, and about 3,000,000 shots were fired, consuming 1,250,000 pounds of explosives.

### *United States.*

In 1907, the death rate per 1,000 men employed in the coal mines of the United States, under the most favoured conditions, was 4·86. Dr. Joseph A. Holmes, chief of the technologic branch of the United States Geological Survey, states that 2,450 men lost their lives in coal mine accidents, during 1908. Since 1889, no less than 22,840 men were killed in coal mine accidents alone. Indeed, so serious was the state of affairs that in 1908 the federal government of the United States appointed a special commission, consisting of three foreign experts—Captain Desborough, who has charge of the United Kingdom testing station, being one of the number—to investigate the matter. They reported that the high percentage of mine accidents was in large part due to the unrestricted use of explosives.

On the recommendation of the above-mentioned Commission, the United States Government began at once to establish testing stations, the principal one being at Pittsburgh, Pa.

### *Canada.*

In attempting to collect facts relating to accidents from explosives in Canada, the quest was found to be very unsatisfactory, since no centralized system for gathering such data is in existence. The Department of Labour tabulates all the facts available, but its information is largely derived from newspaper clippings; the Railway Commissioners obtained reports of accidents due to operation only, and not on construction; the Provincial governments record the accidents in mines, but not in any other class of work, and do not always obtain complete returns as to the number of employes and their occupations.

The following is a statement prepared by Mr. J. G. S. Hudson, of the loss of life in our coal and metalliferous mines during the interval 1899-1908.

In Canada the average for 10 years—1889 to 1908, per 1,000 men, was:—

| | |
|---|---|
| British Columbia— | |
| Coal mines | 9·21 |
| Nova Scotia— | |
| Coal mines | 2·67 |
| British Columbia: 1908— | |
| Metalliferous mines | 5·93 |

Ontario: 1907—[1]

| | |
|---|---|
| Copper and nickel | 2·19 |
| Silver and iron | 7·36 |

According to the Annual Report of the Ontario Bureau of Mines[2], in 1908 there were 13 fatal accidents underground in the silver producing mines of Cobalt. The published returns state that there were 1,089 men employed underground in these mines, so that the ratio for fatalities becomes 11·94 per 1,000 employes underground. There were also 14 fatal accidents underground in the non-producing mines, including several accidents in sinking shafts, but the number of men employed in these mines is not recorded. In addition, 3 fatal accidents above ground make a total of 30 fatal accidents in the Cobalt district. The total force employed, above and below ground, was between 3,500 and 4,000 men.

In England, the average loss of life in mines, per 1,000 men employed, during the years 1903 to 1907, was:—

| | |
|---|---|
| Coal mines | 1·29 |
| Metalliferous mines | 1·08 |

The greater number of fatalities in Canadian mines, as compared with those in Great Britain, is manifestly due to the enforcement of wise laws and regulations in the latter case, and to the utter absence of protective legislation in the former. Hence, with a view of providing a remedy, I have recommended that a central station —similar to those established in England and the United States—be built in Ottawa, for the testing of all explosives: and that an Explosive Act be passed effectively regulating the manufacture and sale of explosives, their use in mines, and in blasting operations generally.

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[1] Mines and Quarries Report for 1907; Part IV, Colonial and Foreign Statistics; page 296, Home Office, London, 1909.

[2] 18th Annual Report, pp. 14, 69, 70, and 94.

## Table showing Fatal and Serious Accidents in the Coal Mines of British Columbia and Nova Scotia.

| Year. | British Columbia. — Output of Coal in Tons. | British Columbia. — Number of Men Employed. | British Columbia. — Accidents. | | | British Columbia. — Ratio per 1,000 men employed. | | | Nova Scotia. — Output of Coal in Tons. | Nova Scotia. — Number of Men Employed. | Nova Scotia. — Accidents. | | | Nova Scotia. — Ratio per 1,000 men employed. | | | United Kingdom. — Fatal Accidents. — Ratio per 1,000 Men Employed. | United States. — Fatal Accidents. — Ratio per 1,000 Men Employed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fatal. | Serious. | Slight. | Fatal. | Serious. | Slight. | | | Fatal. | Serious. | Slight. | Fatal. | Serious. | Slight. | | |
| 1899.... | 1,306,324 | 3,780 | 11 | 29 | 30 | 2·91 | 7·67 | 7·94 | 2,642,333 | 5,612 | 19 | 26 | 4 | 3·39 | 4·65 | 0·07 | 1·26 | 2·98 |
| 1900.... | 1,590,179 | 4,178 | 17 | 43 | 38 | 4·06 | 10·09 | 9·07 | 3,238,245 | 6,626 | 21 | 18 | 13 | 3·17 | 2·17 | 1·20 | 1·30 | 3·24 |
| 1901.... | 1,691,557 | 3,974 | 102 | 34 | 31 | 25·67 | 8·59 | 7·88 | 3,625,365 | 7,663 | 14 | 33 | 8 | 1·82 | 4·30 | 1·04 | 1·36 | 3·24 |
| 1902... | 1,641,626 | 4,011 | 139 | 21 | 18 | 34·65 | 5·23 | 4·48 | 4,366,869 | 8,062 | 21 | 26 | 12 | 2·60 | 3·22 | 1·49 | 1·24 | 3·49 |
| 1903.... | 1,481,913 | 4,264 | 42 | 33 | 26 | 9·85 | 7·74 | 6·09 | 5,255,247 | 11,092 | 31 | 64 | 9 | 2·88 | 5·76 | 0·81 | 1·27 | 3·14 |
| 1904 ... | 1,685,698 | 4,453 | 37 | 41 | 16 | 8·31 | 9·20 | 3·59 | 5,247,135 | 11,659 | 27 | 55 | 33 | 2·40 | 4·71 | 2·83 | 1·24 | 3·38 |
| 1905.... | 1,825,832 | 4,407 | 12 | 30 | 26 | 2·72 | 7·03 | 5·90 | 5,050,420 | 10,780 | 20 | 55 | 19 | 1·85 | 5·10 | 1·76 | 1·35 | 3·53 |
| 1906.... | 1,899,076 | 4,805 | 15 | 36 | 32 | 3·12 | 7·49 | 6·66 | 5,866,605 | 12,123 | 29 | 58 | 16 | 2·39 | 4·79 | 1·32 | 1·29 | 3·40 |
| 1907.... | 2,219,608 | 6,059 | 31 | 61 | 62 | 5·11 | 10·06 | 10·23 | 5,720,660 | 12,107 | 37 | 59 | 22 | 3·05 | 4·87 | 1·81 | 1·32 | 4·86 |
| 1908.... | 2,109,387 | 6,095 | 18 | 50 | 52 | 2·95 | 8·20 | 8·53 | 6,299,282 | 12,933 | 45 | 97 | 82 | 3·48 | 7·50 | 6·34 | 1·32 | 3·55 |
| | 17,451,200 | 46,036 | 424 | 378 | 331 | 9·21 | 8·21 | 7·19 | 47,312,161 | 98,657 | 264 | 493 | 218 | 2·67 | 4·99 | 2·21 | 1·295 | 3·48 |

## GOVERNMENT PEAT BOG AT ALFRED, ONTARIO.

In my last Summary Report (page 8) the proposed government plant for the manufacture of air dried peat is described as an 'Experimental Peat-Fuel Plant.' The word 'experimental' should have been deleted, for the Anrep method of treating and preparing the peat for fuel purposes, has passed the experimental stage. In Russia and Sweden the system is an assured commercial success. The main objective, therefore, in establishing the plant at Alfred, is to demonstrate practical methods by which the country's immense resources of peat may be economically utilized as a substitute for coal.

It has been estimated that the known peat bogs of Canada, which are probably only a small fraction of the total, cover approximately, an area of 36,000 square miles, from which about 28,000,000,000 tons of air-dried peat could be produced. This would be equal in fuel value to about 14,000,000,000 tons of coal.

The comparative fuel value of peat, coal, and wood is: 1 ton of the best coal is equal to 1·8 tons of peat, or 2·5 tons of seasoned wood.

Realizing that in matters industrial it is good Canadian policy to begin where Europe left off, and armed with the practical knowledge gathered in an exhaustive study—on the spot—of the peat industry of northern Europe, the peat problem in Canada is being attacked systematically by the Mines Branch. Ten bogs have already been investigated, six of which are graphically described in Bulletin No. 1, published June 30, 1909, and now in its second edition. The others are referred to in Mr. Anrep's preliminary report, and will be fully described and mapped in Bulletin No. 2, to be issued shortly.

Conceiving that the most effective manner in which to awaken public interest in the ultilization of our peat resources would be the establishment of a plant on a commercial scale, equipped with the machinery and appliances which have been successfully used in European practice, a peat bog of 300 acres, with an average depth of 8 feet, was acquired by the Government, at Alfred, near Caledonia Springs, Prescott county, Ont. About five miles of ditches have been dug; a storage shed to hold 300 tons of air-dried peat, a blacksmith's shop, and an office, have been built. The following modern machines, etc., have been installed:—

> Anrep peat machine, with conveyer, having a productive capacity of 25 to 30 tons of air-dried peat per day. A 35 horse-power steam engine and boiler combined; cable appliances for transporting peat about 1,200 feet; Jacobson field press; circular track for transporting dumping cars to field press—about 1,200 feet long; eight steel dumping cars, each 0·7 tons capacity; and about 2,500 feet of 600 mm. gauge field track has been laid.

This plant will be in active operation at the end of April, 1910, and interested parties may see for themselves the operations of a modern plant for the economic production of peat fuel.

## FUEL TESTING STATION AT OTTAWA.

During the summer of 1909, a substantial brick building, suitable for equipment with modern fuel testing machinery and appliances, was built on Dolly Varden and Division streets, Ottawa. There is also a storage shed at the south end of the

lot capable of holding 150 tons of peat fuel. (See Plate II). The present installation consists of a Körting Peat Gas Producer, with the necessary cooler, scrubber, tar extractor, etc., a Körting 60 horse-power, 4 cycle gas engine; a Westinghouse 50 kw. dynamo—direct connected; and a portable resistance of 60 kw. capacity, for the purpose of absorbing the load when making tests; also a switchboard, with the necessary measuring and testing instruments.

The main building is divided longitudinally into two parts: one of which is occupied by the peat gas producer and its auxiliary apparatus—with office at the north end; while the other half is divided by a partition wall into two compartments: one being occupied by the gas engine and dynamo; the other reserved for an ore-dressing laboratory to be equipped with a 40 horse-power motor and concentrating machinery—the power for which is to be supplied by electric energy generated in the adjoining peat gas plant.

The gas generating room has been made large enough to accommodate other types of gas producers—specially designed for using bituminous coal or lignite, as fuel—which it is purposed to install in the near future.

The peat plant at Alfred has been installed under the supervision of Mr. A. Anrep, jr., of the Mines Branch staff; while the peat gas producer, with its auxiliary apparatus and machinery, has been installed—under the general supervision of Mr. B. F. Haanel, of the Mines Branch staff—by an expert sent by Körting Bros., from Hanover, Germany.

It is expected that the Fuel Testing Station will be in full operation and open for inspection by the general public by the end of April.

So many extravagant statements have appeared in the public press relative to the economic use of peat for domestic and power purposes, that it is necessary to reiterate and to emphasize the warning made before the Conservation Commission Convention at Ottawa, that the transportation to great distances of low-grade fuel—such as air-dried peat, is *not recommended,* either for domestic or for power purposes.

It is estimated that the expense of erecting a peat plant capable of producing 30 tons of air-dried peat daily should not exceed $7,000: and since workable peat bogs are scattered throughout the farming regions of Ontario and Quebec, the most economical plan for utilizing this fuel would be the erection of a number of plants at strategic points to be operated in the interests of the neighbouring communities.

## PEAT BY-PRODUCTS: MOSS LITTER, AND PEAT MULL.

Not only is peat a valuable asset as a substitute for coal, but those classes of peat which are practically useless for fuel are extensively utilized by European farmers as moss litter. In fact, the manufacture of this litter, and its by-product 'peat-mull,' has become a well established industry in Sweden, Germany, and Holland.

Peat mull—obtained as a by-product in the manufacture of moss litter—is an excellent material for packing fruit and plants for storage and shipping. Its antiseptic properties and great affinity for moisture render it invaluable as a preventive of decay in fruit.

Peat Plant at Alfred, Prescott County, Ont.

Fuel Testing Station, Ottawa.

In Norway some 200, and in Sweden between 300 and 400, small plants are in operation making this material; while in Germany and Holland—where there are a number of large plants—the manufacture of moss litter has become a flourishing industry. Most of the smaller plants are owned by groups of farmers, who work the bogs themselves.

Inasmuch as moss litter is—in many cases—a by-product in the making of peat fuel, its exploitation would materially reduce the cost of manufacturing peat fuel, if placed on the market commercially in conjunction with peat mull. Several shipments of moss litter from Holland have been made to the United States—at $16 per ton.

The different Departments of Agriculture in European countries very strongly urge farmers to use moss litter.

Seeing that Canada is fast becoming an important fruit exporting country, it is evident that the use of peat mull as a packing material would be a great economic advantage.

## ON THE OIL-SHALE INDUSTRY.

Next to the electric smelting of iron ores and the solution of the peat fuel problem, no subject has evoked such commercial interest recently as the prospective supply of mineral oil from the bituminous shales found in various parts of the country—notably in New Brunswick and Nova Scotia.

### New Market for Oil-fuel.

One ton of mineral oil is equivalent—as regards calorific value—to about two tons of coal, a fact which has led to its recent introduction as oil-fuel into the British navy.[1] This fact has also attracted considerable attention in the Maritime Provinces, especially in view of the prospective building of a Canadian navy. According to the report of Dr. Ells[2] the immense deposits of oil-bearing shales in eastern Canada are richer in hydrocarbons than the average Scotch shales, and in the manufacture of crude oil and sulphate of ammonia therefrom 'there would be a total gain over the Scotch shale of $3.73[3] per ton.

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1. 'Oil is likely to be a permanent form of fuel in the British Navy, and it is largely this fact that has given strength to the market. There is, of course, a wide difference between the actual purchase by the Admiralty and the potential consumption of the Navy. The actual annual production of the Scottish paraffin oil companies may be taken at from 150,000 to 200,000 tons per annum. The potential consumption of the British Navy may be considered to be about 1,500,000 tons per annum, on the basis of one ton of oil to two tons of coal, which is the equivalent usually considered to be correct. To supply the furnaces of such vessels as can burn oil-fuel quantities must be secured from abroad.

*'Foreign Sources of Supply.*

'The production of petroleum in the world is about 40,000,000 tons per annum; about 95 per cent is the output of foreign countries. The United States yield about 64 per cent of the whole; and then come Russia, with 22 per cent; Galicia, with 4·50 per cent; Roumania, with 3 per cent; Mexico, with 1·25 per cent, and so on. The proportions of the total supplied by British possessions are as follows:—India, about 2 per cent; Canada, about 0·20 per cent; Borneo, about 3 per cent; and Scotland and other places about 0·05 per cent. In plain English, we could not adopt oil as the sole fuel for our Navy without making large contracts for supplies with some foreign power or powers.' The *Times* (London), March 11, 1910.

2. Joint Report on the Bituminous, or Oil-shales of New Brunswick and Nova Scotia, also on the Oil-shale Industry of Scotland. Part I Economics, Part II Geology. By Dr. R. W. Ells, Mines Branch, Department of Mines, Ottawa, 1910.

3. Journal of the Mining Society of Nova Scotia, Vol. XV., February, 1910, p. 25.

From the foregoing facts it is manifest: (1) that Canada has extensive deposits of rich, oil-bearing shales; (2) that these oil-shale resources can be utilized for the manufacture of mineral oil and ammonium sulphate at a profit; and (3) that there is bound to be not only a large Canadian trade, but a larger profitable market within the empire.

### Oil-shale Testing Laboratory.

To assist prospective operators of oil-shale works, the chemical laboratory of the Mines Branch at Ottawa has been equipped with modern chemical apparatus and the latest mechanical appliances for demonstrating practical methods of producing crude oil and sulphate of ammonia from oil-shales by destructive distillation. A detailed description of both methods and apparatus—written by Harold Leverin, Ch.E.—will be found in Appendix II.

## MAGNETOMETRIC SURVEYS.

There is one special feature of Mines Branch work which is proving to be of increasing importance in the development of the mineral resources of the country, namely, *magnetometric surveying.* This system is described in my 'Report upon the Location and Examination of Magnetic Ore Bodies by Magnetometric Measurements,' published in 1904; and is explained popularly in Appendix IV.

For the last seven years, this method has been applied with increasing efficiency and success by members of my staff; and that the work is being appreciated is evident from the constant applications being made for special surveys. Moreover, it is interesting to note that the publication of our series of magnetometric survey maps is attracting attention abroad. The system was first applied in Sweden about the year 1879; but the work of the Department of Mines of the Canadian government, in formularizing the method into a coherent, practical system, is evoking appeals for Mines Branch literature[1] on the subject even from Sweden.

A special request has been received from the Technological Institute of Stockholm, Sweden, for copies of the report on Magnetometric Surveying, issued by the Mines Branch, to be introduced as a text-book; the Geological Commission of Finland has made urgent application for our series of magnetometric survey maps, which they purpose using as aids in the planning of their own survey work.

Early in 1908, Professor C. K. Leith, of the University of Wisconsin, applied for the services of one of our magnetometric surveyors to act as an instructor in the Swedish methods of magnetic surveying. In December, 1909, a similar application was made by Wm. B. Phillips, Director of the Bureau of Economic Geology of the University of Texas. In November, 1909, an experimental table and equipment was installed in Queen's University, Kingston, and Mr. E. Lindeman, of my staff, delivered a short course of lectures on the Swedish methods of magnetometric surveying to advanced engineering students in Kingston. Mr. Lindeman also gave experimental demonstrations of the application of these methods of surveying. This is an event of considerable importance, especially in view of the coming development of our

[1] Report on the Location and Examination of Magnetic Ore Bodies by Magnetometric Measurements. Dr. Eugene Haanel, Mines Branch, Department of Mines, Ottawa.

magnetic iron ore resources, and the lectures and demonstrations should be of practical interest and value to the mining engineering students. As stated in my report[1] of 1904, p. 98:—

> Without such an experimental knowledge gained in the laboratory, and relying simply upon his theoretical knowledge of the subject, the observer will often, after having plotted his observations and drawn his curves, find himself unable to arrive at sound conclusions regarding the limit and distribution of the ore bodies in any complex case. It is for these reasons strongly recommended that mining schools—which desire to take up this subject as part of their curriculum—should provide every facility to their students to render themselves competent, by extended laboratory work, to undertake magnetic surveys, and enable them to correctly interpret the results of their measurements.

## CHEMICAL LABORATORIES.

On account of the increased activity of the Department of Mines, and on account of the large amount of work required by private parties—which latter could not be unduly delayed, since cash for payment of the analyses must always accompany their requests—the chemists of the Mines Branch have not been able to overtake the work; hence to prevent the holding back of reports, it has been necessary to send out work for the Department, to outside chemists. Based on the facts stated, the plea made by Mr. Wait, in his report, for an increase of staff in the Chemical Division, has my earnest endorsation.

During the year the Wellington Street laboratory has been equipped with apparatus and appliances for the destructive distillation of oil-shales, and the determination of ammonium sulphate, as a by-product.

As announced in last year's summary of work done, a detailed report of analyses of ores, non-metallic minerals, fuels, etc., made in the chemical laboratories during the years 1906, 1907, and 1908, has been prepared. It is now passing through the press, and will soon be available for distribution.

## DIVISION OF MINERAL RESOURCES AND STATISTICS.

The work of this Division, which comprises the collection of statistics of mining and metallurgical production throughout Canada, and the collection and recording of information respecting the country's mineral resources, has been carried on during 1909 with commendable activity, and a number of important statistical bulletins have been published.

These include:—

No. 31.—The Production of Cement in Canada during the calendar year 1908.

No. 44.—The Production of Asbestos in Canada during the calendar years 1907 and 1908.

No. 43.—The Production of Chromite in Canada during the calendar years 1907 and 1908.

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1. Report on the Location and Examination of Magnetic Ore Deposits by Magnetometric Measurements, by Dr. Eugene Haanel, 1904. Mines Branch, Department of Mines, Ottawa.

No. 42.—The Production of Iron and Steel in Canada during the calendar years 1907 and 1908.

No. 45.—The Production of Coal, Coke, and Peat in Canada during the calendar years 1907 and 1908.

No. 46.—The Production of Natural Gas and Petroleum during the calendar years 1907 and 1908.

The complete report on the mineral production during 1907 and 1908 was sent to the press in December. The arrears of work in respect of publication of reports which had accumulated in this Division as a result of a decrease in staff, occasioned by the transfer of the Division from the Geological Survey to the Mines Branch, is now being rapidly cleared up. Mr. J. M. Casey was appointed as assistant in the Division in June, and provision has been made for an additional appointment during the coming year.

The rapid growth of the mineral industry is shown in Mr. McLeish's preliminary report for 1909. The production during the past year exceeds $90,000,000 in value, and is the largest production that has been recorded in Canadian mining industry. Statistical information regarding this growing mineral development, to be of the utmost value, should be published at the earliest possible moment, and the policy of publishing advance bulletins as the information becomes available, which was begun in 1909, will be continued during the coming year.

A preliminary review of the mineral production during the year is included in the report of the work of the Division.

It is very satisfactory to note the growth of Canadian metallurgical industries, although there is still room for further development in the home treatment not only of our metals, but also of our non-metallic products. A large iron and steel industry has grown up in eastern Canada, with an annual output of over 750,000 tons of pig iron and about an equal amount of steel ingots and castings. The lead is now nearly all produced as refined pig lead; over 25 per cent of the copper is produced as blister, and the greater part of the balance as matte. Over 55 per cent of the silver production is fine metal and fine silver bullion, while nickel is nearly all produced as Bessemer matte.

At the Trail smelter and refinery in British Columbia, in addition to refined silver and lead, there is produced refined gold, refined antimony, babbit metal, and copper sulphate. In Ontario, white arsenic, in addition to refined silver, is being recovered from the Cobalt District ores treated at Copper Cliff, Deloro, and Thorold. Cobalt oxide is being recovered at Thorold and preparations are being made for the recovery of this metal at Deloro.

A preliminary report, or statistical review of the mineral production of Canada in 1909, will be found as an appendix to this report.

## DOMINION OF CANADA ASSAY OFFICE.

During the calendar year ending December 31, 1909, 48,478·60 ounces of gold bullion, valued at $789,267.96, were received and assayed. These deposits were derived from the following sources:—

| Source. | Deposits. | Weights. | | Value. |
|---|---|---|---|---|
| | | Before melting. | After melting. | |
| | No. | Ozs. | Ozs. | $ cts. |
| Yukon | 81 | 5,130·36 | 5,003·12 | 83,870 84 |
| British Columbia | 458 | 36,708·91 | 35,970·03 | 602,530 77 |
| Alberta | 6 | 60·99 | 41·74 | 766 77 |
| Alaska | 27 | 6,552·33 | 6,535·49 | 101,605 49 |
| California | 1 | 26·01 | 25·89 | 494 09 |
| | 573 | 48,478·60 | 47,576·27 | 789,267 96 |

| | | |
|---|---|---|
| Weight before melting | 48,478·60 | ounces. |
| Weight after melting | 47,576·27 | " |
| Loss by melting | 902·33 | " |

Loss percentage by melting =1·86127.

The earnings of the Assay Office, as shown by the Accountant's statement on another page, were $1,626.45 for the year.

### Diversion of Canadian Gold to the United States.

According to the official report of Mr. G. Middleton—manager of the Vancouver Assay Office (p. 41), there has been a substantial increase of gold output in the Yukon during the year 1909, as compared with 1908; but that very little of this was marketed at the Vancouver office: the decrease in 1909, as compared with 1908, being 57,142·79 troy ounces. It appears that the greater part of the Yukon gold output is now shipped direct to San Francisco by registered mail, the transportation charges from Dawson, Y.T., to San Francisco being the same as from Dawson to Vancouver, B.C. A contributing cause of this diversion of Yukon gold to the United States is the important fact that, the charge imposed in the United States Mint, San Francisco, in the purchase of gold bullion, is one-eight of one per cent less on the gross value of the bullion than at the Vancouver office.

### New Quarters for Assay Office.

For several years past, I have made an annual plea for the erection of a government-owned assay office building in Vancouver, instead of renting a private building, the rent of which has increased 125 per cent in seven years. Fortunately, the expiration of our lease occurred on December 1, 1909, at the same time that the old post-office building on Granville and Pender streets, Vancouver—a centrally located, well-built structure, of commanding appearance—was to be vacated for more commodious quarters, and since the ground floor and basement were found to be admirably adapted

for the purposes of the Assay Office, application was made by the Honourable the Minister of Mines to the Hon. Wm. Pugsley, Minister of Public Works, Ottawa, who placed part of the old post-office at the disposal of the Mines Branch. Seeing, however, that considerable alteration and changes in the building were necessary in order to accommodate the various departments of the Assay Office, and that this would take several months to accomplish, it was perceived that only two courses were open: either to close the Assay Office for three months, or to extend the lease of the existing Assay Office building. The latter course was decided upon, and the lease extended for three months, terminating April 30, 1910, at a rental of $300 per month—an increase of $75 per month.

It is now expected that on May 1, 1910, the Dominion of Canada Assay Office in Vancouver will be firmly established in an admirably adapted, centrally located, government-owned building.

## SCOPE OF INVESTIGATIONS IN THE FIELD.

The general field work of the past season consisted of investigations of occurrences of iron ore, manganese, nickel, and molybdenum in the Provinces of Ontario, Quebec, and Nova Scotia; of the copper and sulphur mining industry in the Province of Quebec, the gypsum industry in New Brunswick and Nova Scotia; and the coal mining industry of Nova Scotia; together with the collection of additional data for the preparation of a second edition of the monograph on asbestos.

The field work in connexion with the investigation of peat consisted in the development of the government peat bog at Alfred, and detailed surveys of several other peat bogs in Ontario.

In addition to the above, the work on coal testing begun at McGill University in 1906 was continued; and laboratory experiments in the concentration of nickeliferous pyrrhotite were carried on in the ore dressing laboratories of Queen's University.

## FIELD WORK.

The following is a brief epitome of the work done by the respective field officers:—

Dr. J. E. Woodman continued his investigation of the iron ore occurrences, and limestone deposits of Nova Scotia, with a view to incorporating the additional data in Part II of his report on the 'Iron Ore Deposits of Nova Scotia'—Part I of which was published July 5, 1909.

Mr. Einar Lindeman was occupied during the first part of the summer in making a magnetic survey of some mining locations on the iron range along the northeast arm of Lake Timagami—the Mines Branch having been petitioned to undertake this work. During the last three months of the field season, Mr. Lindeman made a detailed topographic and magnetic survey of the Bristol iron mine in the Province of Quebec. This work was undertaken in view of the proposed inauguration of electric smelting at the Chats falls; and results of the investigation furnish another demonstration of the utility of magnetometric surveys, since they indicate the presence of two magnetite deposits of considerable importance at only a short dis-

tance east of the place where the principal mining operations were carried on some twenty years ago. The details of the magnetic survey of the Bristol mine will be published as a separate bulletin: accompanied by magnetometric and topographic maps Nos. 60 and 61.

Mr. HOWELLS FRÉCHETTE was engaged from June 1 to October 15, 1909, in the examination of iron ore deposits in central and northeastern Ontario.

In Mayo township, Hastings county, the survey of the Rankin and Child properties—which was unfinished at the close of the season of 1908—was completed.

Deposits were investigated, and ore zones traced in Darling township, Lanark county; Bagot and Blithfield townships, Renfrew county; and South Canonto township, Frontenac county. In this section, the iron ore deposits visited were found to be, in most cases, small, and in several instances merely local enrichments of the country rock with magnetite. He is of opinion that, some of the latter deposits might be workable, but would require magnetic concentration.

Mr. B. F. HAANEL examined—during the summer—some of the most prominent iron mines and prospects along the Central Ontario railway; the Chaffey and Matthews iron mines near Newboro on the Rideau lakes, Province of Ontario; occurrences of iron ore in the counties of Ham and Megantic, Province of Quebec; an occurrence of hematite and magnetite in the vicinity of Gaspereau station on the Canadian Pacific railway, Province of New Brunswick; and an occurrence of titaniferous magnetite near Namegos, a station on the Canadian Pacific railway, Province of Ontario.

Besides this work, Mr. Haanel spent a considerable part of the year in Ottawa, supervising the erection of the fuel testing station, and in the preparation of the report on the electric shaft furnace at Domnarfvet, Sweden. In addition, he investigated a process in Newark, N.J., U.S.A., for the making of gas for power and illuminating purposes from raw peat.

Dr. A. W. G. WILSON spent the summer season studying the present status of the copper mining industry in the Province of Quebec. It appears that at the present time only one mine is shipping ore, namely, the Eustis mine at Eustis, Quebec, all the rest having been either abandoned or having ceased operations. In the course of his investigations Dr. Wilson visited all the known prospects in the Province, and his general conclusion—based upon personal inspection—is, that very few of the abandoned mines or prospects ever contained ore in commercial quantities: most of the deposits consisted of small pockets, which were soon exhausted. Even in those places where the geological indications warranted careful examination, the prospecting had been so manifestly unsystematic, and the methods of exploitation so crude and wasteful, that financial failure was the inevitable result. Dr. Wilson's view with regard to the future of the copper mining industry in Quebec is, that owing to the lack of a suitable, nearby market, and to high transportation charges, only the richer ores can be mined at a profit; and then, only by co-operation between the proprietors of a centrally located smelter and the owners of copper mines.

While in the Eastern Townships Dr. Wilson visited the abandoned antimony mine in South Ham, also a newly discovered locality in the township of Spalding, where

iron ores were said to occur, and incidentally, two localities at which newly discovered talc deposits had been reported, were visited. A statement of the conditions at these several localities will be found on pages 76 and 77 of his summary report.

During the month of December, Dr. Wilson visited the Provinces of New Brunswick and Nova Scotia, for the purpose of planning next season's work in connexion with the investigation of the occurrences of copper ores in Canada generally.

Mr. THEO. C. DENIS was entrusted with an examination of the manganese ore deposits which formerly were actively worked in the Maritime Provinces, with a view to investigating the causes which led to their abandonment. It was thought that some of the mines might be re-opened as a source of manganese for the steel industry in Canada and in the United States; but Mr. Denis is of opinion that these deposits could not be worked economically enough to enable Canadian producers to compete with the manganese ores mined in Russia, India, and Brazil. The Canadian ores of manganese are, however, of exceptional purity, and would probably bring higher prices than the ores now used in the iron and steel industry.

In addition to this work, Mr. Denis spent much time writing and revising a report on the coal fields and coal mines of Canada. This report is intended as a popular description of the coal resources and coal industry of Canada; and is to accompany the report on the coal tests now being prepared under the auspices of the Mines Branch.

Mr. Denis also prepared, at my request, numerous notes and memoranda of a technical nature, in answer to inquiries concerning mineral deposits, mining operations, etc.

Mr. W. F. JENNISON continued his work of investigating the gypsum resources of Nova Scotia and New Brunswick; and in addition, examined the deposits on the Magdalen islands in the Gulf of St. Lawrence. In the early part of the year he visited the districts in the United States where gypsum is manufactured into plaster of Paris, stucco, cement plaster, flooring plaster, alabaster ornaments, fertilizer, etc. Judging by the data incorporated in his preliminary report on page 89, his detailed report, now in preparation, should be a comprehensive and valuable addition to the growing series of Mines Branch publications on the economic minerals of the country.

Dr. T. L. WALKER—carrying out the project announced in my last summary report—spent two months of last summer investigating the occurrence of molybdenum ores in Canada. The chief commercial value of molybdenum consists in its utilization as an ingredient of high grade tool steel and of magnet steel. By the addition of molybdenum, steel is enabled to retain its temper when heated to a comparatively high temperature. In addition to his investigations in Nova Scotia, New Brunswick, and Quebec, Dr. Walker visited the molybdenum fields in Maine, United States, where he not only studied the occurrences of the ore, but inspected the methods of quarrying, crushing, and dry concentration. The data gathered are to be incorporated in an illustrated monograph on the subject.

Mr. G. C. MACKENZIE, B.Sc., on September 22, 1909, commenced to gather typical samples of magnetic iron ores, high in sulphur, from the Bristol mines, situated in the township of Bristol, Pontiac county, Quebec; and similar, but more siliceous

merchantable iron ores from the Bathurst mines, situated in the township of Bathurst, Gloucester county, New Brunswick. These, he subsequently analysed, and subjected to concentration tests: crushing, grinding, classifying, and magnetic separation—by both wet and dry methods—in the mining laboratory of the School of Mining, Kingston, Ontario, temporarily rented for the purpose.

In addition to the foregoing experiments on magnetic iron ores, Mr. Mackenzie, in November, began concentration tests with selected nickeliferous pyrrhotites. The results of the respective chemical analyses, together with tabulated statements showing the various concentration tests, are to be found in his preliminary report on page 54.

Mr. Fritz Cirkel, in 1909, continued his study of the asbestos region of Quebec. One important work achieved was the delimitation of the exact position of the continuation of the Serpentine belt in the township of Thetford with that of the adjoining Thetford-Black Lake area. The early part of the year was devoted to plotting his survey of the Broughton Serpentine range; while the summer season was spent inspecting the alleged discoveries of asbestos deposits of magnitude in the township of Thetford. His conclusion with regard to these prospects is that not one of the newly-discovered deposits is of sufficient extent or quality to warrant exploitation; and that only in ranges IV and V of that township are the deposits of commercial value.

Mr. Cirkel's preliminary report (page 107) indicates that since September, 1908, the production of asbestos has increased at the rate of 189·20 tons of mill fibre, daily. The second edition of his monograph on 'Asbestos: Its Occurrence, Exploitation, and Uses'—issued in 1905, is now being edited, and will be published in 1910.

Mr. A. Anrep was engaged during the greater part of 1909 superintending the installation of the government peat plant, and draining the bog at Alfred, Prescott county, Ontario. In addition to this work he investigated four peat bogs in the Province of Ontario, and prepared data for maps of these beds. His results will be incorporated in Bulletin No. 2 of 'Investigations of the Peat Bogs, and Peat Fuel Industry of Canada,' to be issued by the Mines Branch in the near future.

Mr. J. G. S. Hudson was employed in the collection and preparation of material for his report on 'Coal Mining in Nova Scotia.' He also gathered information with respect to explosives, their nature and uses, and has been engaged in compiling statistics with reference to accidents in mines.

## GENERAL CONSIDERATIONS.

A general glance over the work outlined in the preceding pages shows that the activities of the Mines Branch have been expanding rapidly, and that new lines of investigations are being started. The most important investigations now being made are (1) the experiments at the Alfred Peat Plant: for the purpose of demonstrating the practicability of economically manufacturing air-dried peat; (2) the demonstrations at the Fuel Testing Station, Ottawa: to show that air-dried peat, and other comparatively low-grade fuels can be utilized economically for power purposes; and (3) the systematic inquiry into the electro-metallurgy of zinc. Special monographs have

already been published on mica, asbestos, graphite, peat and lignite, tungsten, and chrome iron ore; and others on gypsum, building materials and ornamental stones, molybdenum, copper, etc., are in course of preparation. In addition to this special work, important reports on the iron ore resources of the various Provinces—such as Dr. Woodman's on "Iron Ore Deposits of Nova Scotia"—published during 1909—have already been issued; and others are now being prepared. So great has been the demand for certain of the monographs on the economic minerals of the country—particularly asbestos, mica, and peat—that our stock has been completely exhausted; necessitating the issuance of second editions. And a like condition of things prevails with regard to the reports on the smelting of iron ores by the electro-thermic process. A second edition of the report on the Domnarfvet Electric Shaft Furnace was called for, and issued in December, 1909—four months after its publication. Over 35,000 copies of monographs, reports, and bulletins were distributed through the post-office during the year.

The rapid expansion of the mineral industry, now taking place in Canada, is evidenced by the fact that, the total value of mineral products for the year 1909 was $90,415,763—being second in value only to agriculture. The correspondence in the Statistical Division, alone, amounted to 6,752 letters received and sent; while the correspondence in my own office amounted to 5,491 communications received, and 4,198 sent out.

I have the honour to be, sir,

Your obedient servant,

(Signed) EUGENE HAANEL,

*Director of Mines.*

# REPORTS

ON

# FUEL TESTING, CHEMICAL LABORATORIES, STATISTICAL DIVISION, AND ASSAY OFFICE.

## COAL TESTS AT McGILL UNIVERSITY.

*Dr. John Bonsall Porter.*

The coal tests begun in 1907 have been completed, and the report setting forth the results is now being prepared for the press. It is not yet possible to give any detailed information as to the results of the test, but the following general statement of the character and scope of the work may properly be included in the Summary Report of the Mines Branch.

In the autumn of 1906 the Canadian Government decided to undertake a study of the fuels of the Dominion, somewhat on the lines of the 'Fuel Tests' which had already been commenced by the United States Geological Survey. The Government had not at Ottawa any suitable mechanical laboratories, and as Dr. Porter and Prof. Durley had already done some research work at McGill University on a number of western coals, the Honourable the Minister of Mines asked them to undertake a general investigation of Canadian coals. An arrangement was, therefore, made between the Government and the University, whereby the former undertook to pay for such apparatus and staff as were needed to supplement the testing equipment which the University placed at the disposal of the Government. The Intercolonial and Canadian Pacific railways very generously agreed to handle the material—amounting to many hundreds of tons—free of charge.

In the beginning it was intended to confine the investigation to the coals and lignites of the Dominion, and, owing to limited means, the following points only were covered by the scheme:—

(*a*) Sampling in the field.
(*b*) Crushing and preparing the samples for treatment.
(*c*) Washing and mechanical purification.
(*d*) Boiler trials.
(*e*) Producer trials.
(*f*) Coking trials.
(*g*) Chemical laboratory work

During the progress of the above work, the Department of Mines was organized, and the general supervision transferred from the Geological Survey to the Mines Branch. While there has been no change in the arrangements outlined, an additional investigation has been initiated by Dr. Eugene Haanel, Director of Mines, who has undertaken an exhaustive study of the peat deposits of Quebec and Ontario, and has commenced the erection at Ottawa of a peat fuel testing station. The immediate necessity of this second investigation will be realized when it is stated that no coal fields of importance occur in Canada between eastern New Brunswick

in the east. and Saskatchewan and western Manitoba in the west—a distance of over 2.000 miles; while throughout this great coalless territory there are numerous, and very extensive bodies of peat, which are all, as yet, wholly undeveloped. Seeing, however, that the investigation of peat is being conducted by the Mines Branch, directly, it is unnecessary to deal further with it here.

Canada possesses a number of coal fields which may be grouped, roughly, into four great divisions: three of which are of present importance.

(1) *The Maritime Provinces:—*

Nova Scotia and New Brunswick—

Bituminous coal only.. .. .. .. ..10,000,000,000 tons estimated.

(2) *The Central Plains and the Eastern Rocky Mountains:—*

Manitoba, Saskatchewan, Alberta, British Columbia—

| | | |
|---|---|---|
| Anthracite.. .. .. .. .. .. .. | 400,000,000 | tons estimated. |
| Bituminous.. .. .. .. .. .. .. | 80,000,000,000 | " |
| Lignite.. .. .. .. .. .. .. .. | 80,000,000,000 | " |

(3) *The Pacific Coast, and the Western Mountains:—*

British Columbia and the Yukon—

| | | |
|---|---|---|
| Anthracite.. .. .. .. .. .. .. | 10,000,000 | tons estimated. |
| Bituminous.. .. .. .. .. .. .. | 2,000,000,000 | " |
| Lignite.. .. .. .. .. .. .. .. | 1,000,000,000 | " |

(4) *The Arctic-Mackenzie Basin:—*

Lignite only.. .. .. .. .. .. .. .. 500,000,000 tons estimated.

In addition to the above, there are certain small fields—notably one in Ontario—of no present interest, containing some millions of tons of lignitic peat, and others of doubtful extent and value in the far north.

The coals of section (1)—Nova Scotia—are similar to the ordinary grades of English and Scotch coal; although in the average they may have a little more ash, and considerably more sulphur than the British seams of the same thickness. Most of them make fair coke, and on the whole may be taken as being fair to good steam coals, and excellent for domestic use. These coals are largely exploited, and, at present, provide the largest part of Canada's supply.

The coals of section (2) are enormous in quantity, and many of them excellent in quality: some of the best Crowsnest coals being admirable in every respect. These coals are, however, all of comparatively recent age geologically (Cretaceous), and, with the exception of the lignites, which occur chiefly in the plains, they are found in the main uplift of the Rocky mountains, in beds much tilted, and often very irregular. The coals are, consequently, less uniform in quality than they would otherwise be, and many of them carry large quantities of ash, either inherent, or, as an unavoidable admixture from mining operations.

These coals are largely exploited: the anthracite by the Canadian Pacific railway near Banff; the bituminous coals, by many companies, most of which are operating in the neighbourhood of the Crows Nest Pass branch of the Canadian Pacific railway; the lignites in numerous places in southern Alberta, and near Edmonton; also at many points in Saskatchewan and Manitoba.

The bituminous coals are, as stated above, very variable: ranging from very high grade steam coals, down. Some of these coals make admirable coke, others will do so if first washed free from their excessive impurities; others do not coke well or at all, but are useful for steam and domestic purposes. Others—and this includes the greater part—are still unexploited, and lie to the north of present lines of traffic; but all, or nearly all, are where they can easily be made available as the country becomes settled.

The western coast coals are best developed in Vancouver island, where they have been mined for many years, also in Graham island to the north, where mining has not yet begun; but smaller, although important, fields are found in many localities, notably at Princeton on what will probably become the line of the western extension of the Crows Nest Pass branch of the Canadian Pacific railway, at Nicola, near the main line of the Canadian Pacific railway, at Telkwa, near the line of the Grand Trunk Pacific railway, and at Tantalus, near the upper navigable waters of the Yukon.

The Vancouver Island coals are more or less normal bituminous, and some of them coke well. The others are largely, but not wholly lignite or lignitic-bituminous. Some coke well, but most of them are likely to prove unsuitable for metallurgical purposes (smelter coke); in general, however, they are excellent for domestic use and also for steam raising. Their impurities vary greatly, but on the whole these coals may be likened to those of the second division.

With such vast coal resources, of which but a comparatively small part is developed, it is, of course, impossible for any investigation to be made exhaustive, and in the present case no attempt has been made to deal seriously with any coals except those from mines already developed, and in condition to place their material on the market. Nearly all the mines in this condition have been sampled, and their product tested on a fairly large scale—usually 10 tons.

In the following list the coals tested are arranged geographically: beginning with the eastern part of the Atlantic coal field of Cape Breton, Nova Scotia.

LIST OF COALS TESTED.

50. Gowrie seam, North Atlantic Collieries, Ltd., Port Morien, N.S.
36. Dominion No. 7, Hub seam, Dominion Coal Co., Ltd., Glace Bay, N.S.
35. Dominion No. 9, Harbour seam, Dominion Coal Co., Ltd., Glace Bay, N.S.
35SP. Dominion No. 5, Phalen seam, Dominion Coal Co., Ltd., Glace Bay, N.S.
38. Dominion No. 1, Phalen seam, Dominion Coal Co., Ltd., Glace Bay, N.S.
37. Dominion No. 10, Emery seam, Dominion Coal Co., Ltd., Glace Bay, N.S.
39. Dominion No. 12, Lingan seam, Dominion Coal Co., Ltd., Glace Bay, N.S.
13. No. 1 colliery, Nova Scotia Steel and Coal Co., Ltd., Sydney Mines, N.S.
12. No. 3 colliery, Nova Scotia Steel and Coal Co., Ltd., Sydney Mines, N.S.
14. Inverness colliery, Inverness Railway and Coal Co., Inverness, N.S.
15. Port Hood colliery, Richmond Railway Coal Co., Ltd., Port Hood, N.S.
4. Six foot seam, Vale colliery, Acadia Coal Co., Ltd., New Glasgow, N.S.
16. Foord seam, Allan shaft colliery, Acadia Coal Co., Ltd., Stellarton, N.S.
1. Third seam, Albion colliery, Acadia Coal Co., Ltd., Stellarton, N.S.
2. Cage Pit seam, Albion colliery, Acadia Coal Co., Ltd., Stellarton, N.S.
8. Main seam, Acadia colliery, Acadia Coal Co., Ltd., Westville, N.S.
3. Main seam, Drummond colliery, Intercolonial Coal Mining Co., Ltd., Westville, N.S.
49. No. 1 colliery, Cumberland Railway and Coal Co., Ltd., Springhill, N.S.
5. No. 2 colliery, Cumberland Railway and Coal Co., Ltd., Springhill, N.S.
6. No. 3 colliery, Cumberland Railway and Coal Co., Ltd., Springhill, N.S.
7. Chignecto colliery, Maritime Coal, Railway and Power Co., Ltd., Chignecto, N.S.
9. Minudie colliery, Minudie Coal Co., Ltd., River Hebert, N.S.
10. Joggins colliery, Canada Coals and Railway Co., Joggins, N.S.
11. King's mine, G. H. King, Minto, N.B.
40. Western Dominion Collieries, Ltd., Taylorton, Sask.
41. Eureka Coal and Brick Co., Ltd., Estevan, Sask.
46. Strathcona Coal Co., Ltd., Strathcona, Alta.

42. Parkdale Coal Co., Ltd., Edmonton, Alta.
45. Standard Coal Co., Edmonton, Alta.
43. Canada-West Coal Co., Ltd., Taber, Alta.
44. Galt colliery, Alberta Railway and Irrigation Co., Ltd., Lethbridge, Alta.
47. Breckenridge and Lund Coal Co., Ltd., Lundbreck, Alta.
48. Seven foot seam (No. 1, Byron), Leitch colliery, Leith Collieries, Ltd., Passburg, Alta.
32. Hillcrest colliery, Hillcrest Coal and Coke Co., Ltd., Hillcrest, Alta.
33. No. 1 seam, Bellevue colliery, West Canadian Collieries Co., Ltd., Bellevue. Alta.
28. No. 1 seam, Lille colliery, West Canadian Collieries Co., Ltd., Lille, Alta.
34. No. 2 seam, Denison colliery, International Coal and Coke Co., Ltd., Coleman, Alta.
34SP. No. 4 seam, Denison colliery, International Coal and Coke Co., Ltd., Coleman, Alta.
31. No. 3 mine, Michel colliery, Crowsnest Pass Coal Co., Ltd., Michel, B.C.
30. No. 7 mine, " " " "
29. No. 8 mine, " " " "
51. No. 2 seam, South Hosmer Mines, Ltd., Hosmer, B.C.
52. No. 6 " " " "
53. No. 8 " " " "
53. No. 8 " " " "
27. No. 2 mine, Coal creek, Crowsnest Pass Coal Co., Ltd., Fernie, B.C.
26. No. 5 " " " " " "
25. No. 1 or Old mine, H. W. McNeil Co., Ltd., Canmore, Alta.
23. Bankhead colliery, Bankhead Mines, Ltd., Bankhead, Alta.
24. Briquettes from Bankhead colliery, Bankhead Mines, Ltd., Bankhead, Alta.

Ex. 1, No. 1 opening, Granite Creek, B.C.
Ex. 2, No. 2 " " "
Ex. 3, No. 4 " " "

22. Jewel seam, No. 1 mine, Middlesboro colliery, Nicola Valley Coal and Coke Co., Ltd., Coutlee, B.C.

22SP. Rat Hole seam, No. 2 mine, Middlesboro colliery, Nicola Valley Coal and Coke Co., Ltd., Coutlee, B.C.

20. Wellington seam, Wellington-Extension colliery, Wellington Colliery Co., Ltd., Extension, B.C.
18. Upper seam, No. 1 mine, Western Fuel Co., Ltd., Nanaimo, B.C.
17. Lower seam, " " " "
21. Lower seam, No. 4 mine, Comox colliery, Wellington Colliery Co., Ltd., Cumberland, B.C.

21SP. Lower seam, No. 7 mine, Comox colliery, Wellington Colliery Co., Ltd., Cumberland, B.C.

Ex. 31. Upper seam, Tantalus mine, White Pass and Yukon Ry. Co., Ltd., Yukon.
Ex. 32. Middle seam, " " " "
Ex. 33. Lower seam, " " " "

A brief statement of the main features of each part of the work of testing will suffice for present purposes.

A. SAMPLING IN THE FIELD.—

The samples were taken by Theophile C. Denis, B.Sc., of the permanent staff of the Mines Branch, Department of Mines; or by Edgar Stanfield, M.Sc., chief chemist of the testing staff, one or other of whom visited and examined each mine to be sampled, and had the coal selected, sacked, sealed, and shipped under their own super-

vision. In taking this main sample every precaution was taken to secure average coal as sold; but in addition, smaller samples were personally secured and sent in sealed tins directly to the chemist.

In some cases, other samples were also taken to determine the difference between the several benches of coal as mined. Seams of minor importance were also sampled in lots ranging from a few pounds to one or more tons.

B. Crushing and Sampling in the Laboratory.—

The main sample on its arrival at the testing plant at McGill was unsacked; crushed to go through a 2″ screen; mixed thoroughly on a large granolithic sampling floor; sampled for the chemist, etc., and finally all re-sacked and set out for treatment.

C. Mechanical Purification—

Each main sample was experimentally treated in the laboratory with heavy solutions, and the fractions analysed with a view to determining the probable results of washing. In all cases where these preliminary tests gave favourable results, a large lot was treated in the coal washing plant of the University: the apparatus used being a standard two compartment slide motion jig, built for the Mines Branch by the Fraser & Chalmers Company. This jig has been specially remodelled for coal washing work, and is provided with automatic feed and side discharge devices for automatically removing the slate and other impurities. The purified coal overflows into a drainage box, in which it is collected and dried. The fine material passing down through the sieves is collected, and is either re-treated or wasted, depending upon its composition. Each of the tests was made on a lot of between 3 and 4 tons, which was first crushed, sized, and then jigged in three separate portions: coarse, intermediate, and small, in order to secure the most accurate work. The very fine coal was also treated when the coal was suitable for coking, or when, for any reason, there was likely to be a commercial justification for saving the fines. The products both of coal and waste were all recovered, weighed, and sampled; but the coarse and fine products were mixed before sending them to the boilers.

The coal washing work was checked by a series of tests with heavy solutions. It would, of course, be possible in a laboratory to do extremely thorough washing at an expense disproportionate to the value of the coal; but this was not attempted, the aim being to reproduce commercial conditions. From comparative tests made between laboratory work, and coal washing in standard plants, it is evident that this end has been attained, and the tests as carried on may be taken to represent average commercial work.

D. Boiler Trials.—

The boiler trials were conducted in the boiler testing room of the Mechanical Engineering Department of McGill University, and the method used was as far as possible in accordance with standard testing practice. The equipment employed in these tests includes a Babcock & Wilcox boiler: having 639 square feet of heating surface, and 16·79 square feet of grate area; an independent feed pump; weighing tanks, and standard scales for water and coal; together with the necessary apparatus for determining moisture in steam, analysing flue gases, and observing pressures and temperatures. Provision was made for supplying steam under the grate, and also for working under forced draft if required. Except in one or two cases where it was necessary to make a change, the same pattern of fixed grate bars was used throughout the tests. These bars have air spaces, the area of which is 30 per cent of the total grate area. If different grate bars had been used for different grades of fuel, better economy in some instances would probably have been obtained; but it was felt that by using the same grate throughout, the tests would be more completely comparable with one another.

Before commencing the tests, the boiler was thoroughly scaled, cleaned, and tested, and all brickwork around the furnace was rebuilt. Preliminary trials were then made with a standard coal (George Creek) to make certain that the whole equipment was in good order. The series of regular tests was then begun, the same fireman being employed throughout. It was not found possible to make more than one boiler trial with most of the samples of coal, and it was decided that in every case the same evaporation of 2,000 pounds of water per hour should be aimed at; this being a rate at which the boiler was known to give nearly its best efficiency. The results of the tests show, therefore, the rate at which each sample of coal had to be burnt in order to furnish a certain supply of steam. As a check, the heat losses in every case were determined as far as possible. All the tests were, at least, of ten hours' duration, and the boiler tubes were, of course, cleaned before each run.

Since the practical working of a coal in the fire has an important economic bearing on its industrial value as a fuel, continuous notes were made of such points as, the condition and thickness of the fire; the nature and amount of ash and clinker formed; the frequency of slicing and cleaning the fire; and the method of firing found most suitable for each particular fuel.

E. Producer Trials—

In the beginning, it was decided to attempt to carry out the boiler and gas producer tests on a somewhat small scale; owing to a wish to make the investigation of immediate value to the numerous small manufacturing and power plants which are springing up all through the country—especially in the west, where for many years they will play a leading part in its industrial development. It was also desired to test all coals with equal thoroughness, and as nearly as possible under identical conditions; and the transportation of even ten ton samples for distances ranging from 800 to 3,000 miles was a sufficiently serious matter. Hence it was decided to work on a scale of approximately 40 horse-power, although it was known that bituminous coal gas producers had not been altogether perfected for so small an output. But assurances were given by several of the leading firms making producers that they could provide the necessary apparatus.

When, however, specifications were prepared and tenders asked for, the makers both at home and abroad exhibited an unexpected reluctance to guarantee their machinery, and much time was lost in correspondence. In the meanwhile, an anthracite producer of approved form was installed, and a series of trial runs on anthracite, coke, etc., were commenced in order to drill the staff, and get the apparatus in working order. Ultimately the makers of two well-known types of producers undertook to build plants for bituminous coal, and did actually erect producers with the necesssary tar extraction apparatus; but in both cases the producers failed to meet the requirements originally specified, and consequently were removed.

The experience gained in the tests above mentioned enabled Professor Durley to design a down draught producer which fulfilled the requirements, and after the long series of preliminary tests necessary to arrive at a trustworthy method of operation, it was possible to begin the final tests on the series of coal samples.

As in the boiler trials, the method of flying start was used; the actual runs lasting 24 hours, and the total operation almost 36. This time was as long as could be managed without a very large increase in the staff, and an even greater increase in the cost; but these 24 hour tests were checked by a sufficient number of longer trials—one lasting 10 days— to show that the apparatus was quite capable of doing commercial work.

Criticism may be made against the use of one producer for all classes of coal—from semi-anthracite to lignite; but in any series of tests it is undesirable to change the apparatus or the conditions of work more than is absolutely necessary. The results, in this case, have justified the course taken. It is scarcely necessary to say that

the scrubbers, washers, tar extractors, etc., were so fitted that they could be cut out by means of valves and by-passes, and that they were not used except when necessary.

F. Coking Trials—

The question, will a certain coal make good coke, is one of great practical importance and until now it has been difficult to answer it without first conducting a series of oven trials on a large and costly scale. Even a full-sized experimental oven is unsuitable for such work, as its operation differs much from that of an oven surrounded by others. The only safe course has been to send a very considerable quantity of each coal, to be tested, to a bank of ovens, and to test it under standard conditions; repeating the operation if necessary with different coking periods until a definite conclusion can be reached.

It was obviously impossible to carry out costly tests of the above character on all of the fifty odd coals in the series under consideration; therefore, an extended investigation was undertaken at the works of the Dominion Iron and Steel Company, Sydney, N.S., with a view to developing some reliable method of working on a small scale. These experiments, supplemented by tests on various types of ovens in different places in Canada, finally led to a satisfactory conclusion: and it is now possible to test coals in lots of, say, 50 pounds, the resultant cokes being in every way similar to those produced in commercial ovens, and in most cases indistinguishable from them.

The method, in brief, is as follows:—

The sample of coal, which should be as fresh as possible, is crushed, washed, if necessary, and slightly moistened in some cases, and is thus brought to exactly the condition in which it would normally go to the ovens. It is then put into rectangular boxes of heavy sheet iron—each holding, say, 50 pounds. These boxes are freely perforated to permit of the escape of gas; but the perforations are blanked with paper to prevent the egress or ingress of coal. The boxes are weighed and placed in an oven which is being charged, and, in fact, become a part of its regular charge, and are coked under perfectly normal conditions. On the withdrawal of the charge the boxes are quenched as promptly, yet as lightly as possible, and are then dried and weighed before being opened.

In addition to the straightforward trials to determine whether the several coals would or would not coke, a series of tests was made to determine the effect of moistening, compressing, etc., also different temperatures, and duration of the coking period.

A method had to be devised, also, to determine the strength of the cokes produced. Mere crushing tests do not suffice, and it was finally decided to adopt a standard method of testing in a tumbler, to determine the losses in handling, and of crushing to a fixed pressure in bulk, to determine strength in coke bins and furnaces.

In addition to the above experiments on the production of metallurgical coke, a limited number of coals have been retorted, and the gases and tar have been studied qualitatively and quantitatively. This work is, however, somewhat beyond the strict limits of the investigation, and it has been impossible to carry it as far as might be desired.

Another series of tests has been made to determine the effect of weathering and of washing on coke production. Some coals will only coke when quite fresh; others will coke—but not so well—when stale; while others do not seem to be affected even by comparatively long exposure to the air. The whole matter is somewhat obscure, and chemical analysis does not cast as much light on it as one could wish.

G. Chemical Laboratory—

The work that had necessarily to be done in the Chemical Laboratory has been very considerable. Methods and apparatus have had to be devised, tested and standardized, and all materials, whether raw, temporary, or final products, have had to be

analysed. No count of the total number of analyses has ever been made, but each complete test of a coal has involved over 400 separate determinations. The following enumeration of the different materials analysed, and of the different analyses, determinations, and investigations carried out, will give some idea of the extent of the work done.

*Materials analysed.*—Coal samples: main, mine, weathering, boiler trial, gas producer tests, coking tests, final washed coal, separate products of washery, specific gravity tests, screen analyses, etc. Coke samples from coking tests; gas samples from boiler trials, gas producer tests, and coking tests; ash samples from boiler trials, gas producer tests, and laboratory combustion of raw and washed coal.

*Chemical Determinations made.*—Carbon, hydrogen, oxygen, sulphur, nitrogen, moisture, ash, volatile matter, fixed carbon, combustible matter, carbon dioxide, carbon monoxide, ethylene, methane.

*Physical Determinations made.*—Fusion temperature of ashes; specific gravity, porosity and strength of cokes; calorific values of solid and gaseous fuels.

*Special Investigations* have been made on the determination of sulphur in coal; determination of volatile matter in coal and coke; solubility of coal in water; determination of physical values of coke; weathering of coal, etc. An investigation is also carried out on the spontaneous combustion of coal in storage, but as this is in addition to the original research and is being supported by private contribution, it is not intended to incorporate the results in the main report.

# CHEMICAL LABORATORIES.

(*a*) Sussex St.
(*b*) Wellington St.

*F. G. Wait, M.A., F.C.S.*

The work done in the chemical laboratories during 1909 has been of the same varied character as in former years, and in the twelve months ended December 31, 875 specimens have been examined and reported upon.

During recent years there has been a gradual increase in the number of specimens received from persons other than the regular field staff of the Department. To such an extent have these specimens increased that the time of our present staff was almost fully occupied in attending to this commercial work. Not only was the legitimate function of the laboratory interfered with; but as no charge was made for such work, it was felt that we were entering into unfair competition with chemists in private practice outside. To overcome this latter condition of affairs, and in order to divert as much of this purely commercial work as possible into other channels, a schedule of charges was drawn up, and, after approval by the Honourable the Minister of Mines, became effective on June 29, 1909.

There has been only a slight diminution in the number of such specimens received, and, as prepayment of charges is demanded, it is scarcely possible to postpone the required examinations. In consequence, as matters stand to-day, we are not able to keep abreast of the work coming to us from our own staff. As a matter of fact, in order that reports might not be unduly delayed, I have been obliged to recommend that some of our chemical work be done by outside chemists. This is a state of affairs which should not exist; but if the chemical work of the Department is to be done—as it assuredly ought to be—within our own walls, it is imperative that our present staff be augumented, and our accommodation be increased, and re-arranged accordingly.

A detailed report of the work done during 1906, 1907, and 1908 has been prepared, and is now in the press.

In carrying out the work during the year, Mr. M. F. Connor, B.Ap.Sc., and Mr. H. A Leverin, Ch. E., have rendered faithful and efficient service.

The work done during the year may, for convenience, be arranged as follows:—

I. Fuels, comprising:—

1. *Peat*—2 samples from—
   (a) New Brunswick—An undefined locality.
   (b) British Columbia—Lulu island.

2. *Lignite*—36 samples from—
   (*a*) Saskatchewan.
      i. South shore of Bear (Pipe) lake—in unsurveyed territory.
   (*b*) Alberta.
      i. Leitch's collieries, at Passburg—5 samples.
      ii. United collieries—Ritchie mine—Edmonton.
      iii. N.W. Gas and Oil Co.'s property—Jaspar Ave., Edmonton. From drill hole No. 2, at a depth of 1,440 feet.
      iv. Rakowski's mine—sec. 18, tp. 48, R. 19, W. of 4th.

v. Bower's mine, Canmore—sec. 28, tp. 24, R. 20, W. of 4th.
vi. Threehills mine—sec. 22, tp. 24, R. 31, W. of 4th.
vii. Shaft mine, Threehills—sec. 20, tp. 31, R. 24, W. of 4th.
viii. Ben Nevis 'coal'—sec. 12, tp. 38, R. 22, W. of 4th—2 samples.
ix. Curwin and Kelly's mine—sec. 8, tp. 55, R. 25, W. of 4th.
x. " " —Sturgeon valley, S.E. ¼, sec. 8, tp. 55, R. 25, W. of 4th.
xi. Cardiff mine—N.W. ¼, sec. 24, tp. 55, R. 24, W. of 4th—2 samples.
xii. Alberta Coal Co.'s property, Morinville, Alta.—N.E. ¼, sec. 23, tp. 55, R. 24, W. of 4th; lower part of seam.
xiii. Gillmuth's mine—sec. 34, tp. 38, R. 23, W. of 4th.
xiv. Ketchum's mine—N.W. ½, sec. 7, near Clover Bar, Edmonton.
xv. Clover Bar Coal Co.'s property—N.W. ¼, sec. 7, tp. 23, R. 53, W. of 4th.
xvi. Parkdale Coal Co.'s property—on river lots 22 and 24, Edmonton.
xvii. Standard mine—on river lot 26, Edmonton.
xviii. White Star mine—sec. 25, tp. 51, R. 25, W. of 4th—3 samples.
xix. Strathcona mine—on river lot 7, Strathcona.
xx. Twin City Coal Co., Strathcona—on river lot 19, Strathcona.
xxi. From a large boulder of coal, measuring 30 x 30 x 10 feet, lying on the S.E. corner of Strathcona townsite—on sec. 22, tp. 24, R. 52, W. of 4th.
xxii. Bow Centre mine—secs. 8 and 9, tp. 17, R. —, W. of 4th.
xxiii. Potters' mine, south of Bawlf—sec. 15, tp. 44, R. 19, W. of 4th.
xxiv. Near Round Hill, north of Bawlf.
xxv. From a depth of 100 feet, in the town of Bawlf.
xxvi. Red Willow creek—property of Glen Hays Coal Mining and Development Co., in tp. 40, R. 18, W. of 4th.
xxvii. Star collieries, near Taber—sec. 8, tp. 10, R. 17, W. of 4th.

3. *Lignitic Coals*—7 samples from—
(*a*) Alberta—
i. Lethbridge coal—sec. 25, tp. 9, R. 22, W. of 4th—2 samples.
ii. Russell claim, head of McLeod river—sec. —, tp. 46, R. 23, W. of 4th.
iii. S.W. ¼, sec. 19, tp. 42, R. 26, W. of 4th.
iv. Pacific Pass Coal Co., Little Pembina river—sec. 12, tp. 47, R. 19, W. of 5th—from the upper 6 feet of the seam.
v. Grassy lake, east of Taber.
vi. Athabaska river, two miles below Oldman river.

4. *Coal*—23 samples from
(*a*) Nova Scotia—
i. Vicinity of West Arichat, Richmond county.
(*b*) New Brunswick—
ii. Gloucester county—from a boring 500 feet deep, made by a calyx drill, in Tilley road, Tracadie.
iii. Gloucester county—an undefined locality.
(*c*) Quebec—
i. From a 3 ft. seam in Devonian strata on the beach at Cape Haldimand, Gaspé county.
(*d*) Alberta—
i. From Well No. 2 of the Calgary Natural Gas Co.—2 samples: the first from a depth of 2,582 to 2,587 feet, and the second from 2,656 to 2,664 feet.
ii. North branch of the Brazeau, opposite Prairie camp—on sec. 18, tp. 45, R. 20, W. of 5th; a 3 ft. seam.

iii. Rose creek—sec. 6, tp. 43, R. 19, W. of 5th; seam, 5′-8″.
iv. Smith creek, a branch of the South Brazeau—sec. 24, tp. 41, R. 19, W. of 5th.
v. Russell claim, head of McLeod river—sec.—, tp. 46, R. 23, W. of 5th.
vi. North Branch of the Brazeau—sec. 1, tp. 45, R. 21, W. of 5th—2 samples.
vii. Fiddle creek, a branch of the Athabaska river, near Jasper House, twelve miles south of the G.T.P.
viii. Sec. 9, tp. 44, R. 21, W. of 5th.

(*e*) British Columbia—
i. Vicinity of Hazelton, Skeena mining division—2 samples.
ii. Morice river, Omineca mining division—2 samples.
iii. Vicinity of Babine lake, Skeena mining division.
iv. Granite creek, Similkameen mining division—5 samples.

5. *Anthracitic coal*—8 samples from—
(*a*) British Columbia—
i. Property of the Western Development Co., Skeena River division—6 samples.
ii. Discovery creek, Skeena River division.

(*b*) Yukon—
i. A point two miles west of Union mines, Wheaton River district.

6. *Anthraxolite*—3 samples.

Examination of three samples of what proved to be anthraxolite, from the parish of St. David, three-quarters of a mile west of the town of Lévis, was made upon material selected with the utmost care by Dr. A. W. G. Wilson.

II. Iron Ores—76 samples, comprising:—

1. *Magnetite*, from—
(*a*) Quebec—
i. Pontiac county, Bristol mine—5 samples.

(*b*) Ontario—
i. Timagami district—17 samples.
ii. Frontenac county, South Canonto township—1 sample.
iii. Hastings county, Mayo township—9 samples.
iv. Lanark county, Darling township—6 samples.
v. Renfrew county, Blithfield township—1 sample.

(*c*) Alberta—
i. From the Livingston range—sec. —, tp. 8, R. 3. W. of 5th—2 samples.

2. *Hematite*—from—
(*a*) Nova Scotia—
i. Hants county—1 sample.
ii. Pictou county—15 samples.

(*b*) Ontario—
i. Lanark county, Darling township—6 samples.

3. *Limonite*—from—
(*a*) Nova Scotia—
i. Pictou county, vicinity of Bridgeville—11 samples.
ii. Queens—1 sample.

4. *Ilmenite*—from—
(*a*) Quebec—lots 19 and 20, of South Ham, Wolfe county.

III. Copper Ores—25 samples from:—

(a) Prince Edward Island—

i. Governor island, near Charlottetown—copper content, 51·96 per cent.

(b) Quebec—

i. Bonaventure county—lot 9, R. V. of Matapedia—copper content, 2·61.
ii. Brome county—lot 28, R. IX of Potton—copper, 0·53 per cent.
iii. Sherbrooke county, Ascot township—2 samples from the Suffield mine.
iv. Wolfe county—lot 22, R. II of Weedon—2 samples.

(c) Ontario—

i. Abitibi district—lot 12, con. III, of Clergue; a slightly cupriferous nickeliferous pyrrhotite.
ii. Lanark county, Lavant township—lot and con. not stated.
iii. Nipissing district—Montreal river—3 samples.

(d) Alberta—

i. Vicinity of Banff—copper content 4·16 per cent.

(e) British Columbia—

i. Kaslo—1 sample containing 31·55 per cent of copper.
ii. Phœnix—1 sample from the Snowshoe mine, copper 12·68 per cent.
1 sample from the Brooklyn mine, copper 10·29 per cent.
1 sample from the War Eagle mine, copper 6·10 per cent.
1 sample from the Granby mine, copper 2·00 per cent.
iii. Queen Charlotte islands—5 samples, ranging from 0·43 to 19·11 per cent of copper.

(e) Yukon—

i. Merritt creek—2 samples from the Homestake property.
ii. Williams creek—2 samples, one from the Monte Cristo claim and one from the Bonanza King.

IV. Ores of Nickel and Cobalt—7 samples from:—

(a) New Brunswick—

i. Charlotte county, parish of St. Stephen—nickel, 1·90 per cent.

(b) Quebec—

i. Pontiac county—lot 10, R. XI, of Clarendon.

(c) Abitibi district—lot 12, con. III, of Clergue—nickel, 5·15 per cent.

(d) Nipissing district—4 samples from Montreal river; none contained above 0·47 per cent of nickel.

V. Manganese:—

Four samples of manganiferous limonite—kidney ore—from the vicinity of Bridgeville, Pictou county, Nova Scotia, were found to contain manganese ranging in amount from 31·80 per cent to 0·46 per cent.

VI. Limestones and Dolomites—28 samples from—

(a) Nova Scotia—

i. Cape Breton county—2 samples.
ii. Halifax county—1 sample.
iii. Inverness county—1 sample.
iv. Lunenburg county—5 samples.
v. Pictou county—12 samples.

(b) Quebec—

i. Shefford county—2 samples.
ii. Wolfe county—5 samples.

VII. Brick and Pottery Clays—16 samples from:—

(a) Nova Scotia—
- i. Cape Breton county—1 sample.
- ii. Cumberland county—1 sample.
- iii. Halifax county—2 samples.

(b) Quebec—
- i. St. John county—1 sample, tested with a view to its utilization in cement manufacture.

(c) Saskatchewan—
- i. Near Bienfait—on sec. 12, tp. 2, R. 6, W. of 2nd—8 samples.

(d) Alberta—
- i. Leitch's collieries, near Passburg.

(e) British Columbia—
- i. Vicinity of Enderby—1 sample.
- ii. Vicinity of Ladysmith—1 sample.

VIII. Gypsum—86 samples from—

(a) Nova Scotia—
- i. Cape Breton county—6 samples.
- ii. Colchester county—32 samples.
- iii. Inverness county—22 samples.
- iv. Richmond county—6 samples.
- v. Victoria county—19 samples.

IX. Rock and Mineral Analyses—40 specimens:—

The analyses of rock specimens referred to in my last summary report as being in course of completion have been concluded and reported upon. In all, 38 samples of rocks, and of so-called 'alum rock'—all from British Columbia—and 1 chromiferous and titaniferous magnetite from South Ham, have been done.

X. Oil Shales—42 samples:—

These are all from Albert county, New Brunswick, and have been analysed with a view to ascertaining their value when submitted to destructive distillation by determining the quantity of oil and ammonium sulphate which each produces.

XI. Natural Waters—5 samples from:—

(a) Nova Scotia—
- i. Richmond county—from a boring 470 feet deep, at Cleveland.
- ii. Lunenburg county—from a spring in the vicinity of Riverport.

(b) New Brunswick—
- i. York county—from a spring one mile and a quarter southwest of Astley crossing, in Stanley parish.

(c) Quebec—
- i. Kamouraska county—from a spring at St. Germain—Cadastral lot 36, range I.

(d) Ontario—
- i. Prescott county—from a spring on lot 14, con. VII of Alfred.

XII. Natural Gas—1 sample from Calgary Natural Gas Co.'s well.

XIII. Magnetic Sands.

An examination has been made of 12 metallic (copper) reguli, or buttons, which were prepared by fusion of pure copper with the concentrated and washed portions of stated weights of black magnetic iron sands from different portions of the Dominion. The sands were worked in this way to ascertain their content of heavy metals—gold, platinum, osmiridium—and the copper was added merely as a collector of the heavier metals during fusion.

These sands so treated were from:—

(*a*) Ontario—

i. Shore of Lake Erie.

ii. Granite island, Georgian bay.

iii. Sudbury—2 samples.

(*b*) British Columbia—

i. Queen Charlotte islands—2 samples.

(*c*) Yukon—

i. Near Dawson.

(*d*) Five additional samples were examined, but the locality of their origin was not stated.

XIV. Gold and Silver Assays.

As in the past, the specimens submitted for assay have come from every province of the Dominion, and have represented all kinds of material. During the year just past 250 specimens have been assayed.

These were as follows:—

(*a*) Nova Scotia—6 samples.
(*b*) New Brunswick—2 samples.
(*c*) Quebec—26 samples.
(*d*) Ontario—92 samples.
(*e*) Manitoba—1 sample.
(f) District of Keewatin—1 sample.
(*g*) Saskatchewan—5 samples.
(*h*) Alberta—2 samples.
(*i*) British Columbia—37 samples.
(j) Yukon Territory—6 samples.

In addition to the foregoing, some 72 samples were submitted to assay, but no particulars of locality being furnished, they are not included in the above classification.

XV. Miscellaneous Examinations.

Under this heading are grouped some 200 specimens, or more, which were sent in by mail, or brought by the persons most interested. In many cases a mere description of the material sufficed, in others a partial analysis was required, but in every case report was made, either orally or by letter.

# REPORT OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

*J. McLeish, Chief of the Division.*

In submitting a report on the work of this Division during the calendar year 1909, it is gratifying to be able to say that, although the year was begun with a considerable amount of arrears of work on hand—consisting in the delayed preparation of the final report on the mineral production of Canada during 1907—it closes with the work much more up to date than has been the case for a number of years past.

The main causes which contributed to the delay in the preparation of our annual reports, namely, the greatly increased volume of work on the one hand and a reduction in the staff on the other, have been met, in part (1) by the appointment of one assistant during the year; (2) provision for the appointment of a second; and (3) completion of the reports referred to: which was made possible through the assistance rendered by other members of the Mines Branch staff.

As soon as convenient after the first of January, letters, and circular requests were sent out to the mining community throughout Canada from whom returns of production were desired; and towards the latter part of February sufficient information had been received and compiled upon which to base a preliminary report on the mineral production of Canada during the calendar year 1908.

The manuscript for this report was sent to the printers on February 25, and the printed report (16 pages) was received on March 2. Copies were distributed at the annual convention of the Canadian Mining Institute held at Montreal, March 3, 4, 5, 1909. A paper on the mineral production during the year was also read at the convention, thus placing before the mining community and the public, at the earliest opportunity, information concerning the extent of our mineral output.

In connexion with the early publication of this preliminary report, acknowledgments are due as usual to the various Provincial Mining bureaus for their hearty cooperation in furnishing estimates, and particularly to the Provincial Mineralogist of British Columbia for a detailed preliminary estimate of the mineral production in that Province; also to several of the railway corporations for furnishing statements of the shipments of ores from stations on their lines. Although the figures of output are subject to some variation in the final report—necessarily published much later in the year—the statistics and general résumé showing mining progress furnish a fairly approximate estimate of the mineral production during the year.

The annual report on the mineral production during the calendar year 1906, was not received for distribution until May 18. The revised annual report for 1907 having been completed, it was decided to combine the reports for 1907 and 1908 in one issue: and to publish as separate pamphlets important sections as soon as each was completed. In pursuance of this plan the following reports have been prepared, and sent to press on the dates indicated:—

The Production of Cement in Canada during the calendar year 1908—May 14, 1909.

The Production of Asbestos in Canada during the calendar years 1907 and 1908—August 24, 1909

The Production of Chromite in Canada during the calendar years 1907 and 1908—August 24, 1909.

The Production of Iron and Steel in Canada during the calendar years 1907 and 1908—August 24, 1909.

The production of Coal, Coke, and Peat in Canada during the calendar years 1907 and 1908—August 24, 1909.

The Production of Natural Gas and Petroleum in Canada during the calendar years 1907 and 1908—September 10, 1909.

These were issued as advance chapters of the complete Report on the Mineral Production of Canada during the Calendar Years 1907 and 1908, and were all received and distributed before the close of the year. The complete report was transmitted on December 13. It includes, for the first time, a special chapter on smelter production: returns having been received, through the courtesy of the owners, from all the operating smelters in Canada. A summary of the mineral production in each province has been added into the introduction or general review. Many new tables have been introduced, and old ones condensed and revised. The statistical information respecting structural materials and clay products is also much more complete than formerly, although there is still much room for improvement in this respect.

The publication of statistics of smelter production draws attention once more to a subject that has been fruitful of much discussion, viz., the desirability of securing greater uniformity—as between the various Provincial mining bureaus and the Federal Department of Mines—in the collection, compilation, and publication of mining statistics.

Hitherto, attention has been directed more particularly to the different bases adopted for valuing metallic mineral products. The Bureau of Mines of British Columbia uses a value based on the final value of the refined metal, making no allowance for freight and treatment charges; while the Ontario Bureau of Mines uses such value for the material produced—whether ore or matte—as is placed thereon by the operator; such values representing in general the value of the point of production. The Bureau of Mines of Nova Scotia does not attempt to place any value upon its mineral production, being content with publishing quantities only.

In compiling statistics of metal production from ores—a large portion of which are shipped out of the country for smelting or refining—it is perhaps quite as essential that the estimation of quantities should be on a uniform basis as it is that the valuation should be uniform.

It has become the practice on this continent to describe metal production in terms of fine metal, whether the metal is actually recovered in a refined condition or not. In Canada, quite a considerable tonnage of our ores is exported to be both smelted and refined in other countries; the greater part of our ore tonnage is, however, smelted in local furnaces, the products of which—consisting chiefly of 'blister copper' and 'matte'—are exported for further treatment and refining.

The smelting and refining processes are invariably accompanied by a partial loss of the metals which it is aimed to recover. This loss will vary with different ores and different smelting methods, and may, in special cases, approach as high as 25 to 30 per cent of the original metal contained in the ore.

It will be apparent, therefore, that there will be a very important distinction between statistics of metal production based on exact assays of ores and statistics based on the quantities of metals actually contained in the products 'blister' and 'matte,' etc., produced by the smelters.

The collection of smelter statistics by this Branch for the year 1908—the results of which have been published in the annual report of this Division for that year—has drawn marked attention to this distinction.

As an illustration of the differences here referred to, we may cite the fact that the production of nickel from the Sudbury ores of Ontario is represented both by the Ontario Bureau of Mines and by this Branch as the quantity of nickel contained in

matte which is shipped to the United States and Great Britain for refining. This quantity will be less (from 7 per cent to 10 per cent) than the quantity of nickel contained in the ore sent to the smelter. The same remarks apply to the copper contents of these ores.

On the other hand, in the case of the silver production ot the Cobalt District ores, the production is expressed as so many ounces of fine silver contained in the ore shipped, no allowance being made for the smelter losses. In fact, as the larger portion of these ores is treated in the United States smelters and in conjunction with ores from other sources, it would probably be difficult, if not impossible, to obtain records of the quantity of silver metal actually recovered.

The practice of the Bureau of Mines of British Columbia is to collect statistics based on the assay values of each shipment. The figures given, therefore, represent the 'total gross contents (of shipments) without smelter deductions.' In dealing with such low grade copper ores as those of the Boundary district of this Province (copper contents averaging about 1½ per cent or less), and ores so low in copper as those of Rossland, the difference between statistics of production based on assays and those based on copper recovered by the smelters, will be greatly accentuated. In fact, in cases such as these, the difference as regards copper may approximate as much as 25 per cent or more of the original copper contents of the ore.

The copper production of British Columbia in 1908, according to the statistics published by the Bureau of Mines, representing 'The total gross contents of shipments without smelter deductions,' was 47,274,614 pounds; while smelter returns received by the Mines Branch showed that the quantity of copper contained in the matte and blister produced by the smelters of British Columbia (including the Northport smelter in the State of Washington) was 37,041,115 pounds. A small tonnage of ores was shipped from the coast mines to United States smelters, the results of which are, of course, not included in the latter figure. This amount, however, includes the results of the treatment of a small tonnage of United States ores which were treated in the Canadian furnaces. This difference may at first sight appear somewhat startling, but the explanation is apparent when it is remembered tnat the smelting of the Boundary low grade ores involves a loss of from 25 to 30 per cent of the original copper contained in the ore.

Such conditions do not afford a fair means of comparing the metal production of one province with that of another, nor of comparing the metal production of Canada with that of other countries, where the statistics published represent the quantities of metals recovered.

The collection of statistics of smelter production will be continued by this Division, and an endeavour made to estimate the smelter results of those ores shipped out of the country for treatment, either through actual smelter returns of recoveries or by means of the percentage of metal contents paid for by the customs smelters.

Ores sent to customs smelters are usually paid for on a schedule basis: payment being made for a fixed or variable percentage of the metals contained in the ore, and penalties applied for excess of undesirable constituents. Such schedules, in general, contain many conditions, and vary not only with time, but with each class of ore to which they are applied, as well as with the special requirements of the customs smelter issuing them. Frequently, they will be the result of special negotiations between buyer and seller.

On the basis of such sales of ore, however, it should be possible to obtain statistics showing the quantities of metals—for which payment was made by the purchasing smelter—contained in each shipment.

In reviewing the subject it would appear that the collection of statistics of metal production may properly be viewed from at least four distinct standpoints:—

(1.) Statistics showing the total quantities of metals contained in the ores shipped, as determined by assay, without respect to whether these metals are finally recovered either in whole or in part, or not.

(2.) Statistics showing, in the case of ores sold to custom smelters, the quantities of metals for which payment was made by such purchaser, and, in the case of ores mined and smelted by the same operator, the quantities of metals contained in the smelter products obtained.

(3.) Statistics showing the quantities of metals contained in unrefined products, such as matte, blister, bullion, etc., of the various smelters.

(4.) Statistics showing the actual metal products of refining plants.

Statistics compiled from the first viewpoint, while having an important academic interest, hardly satisfy the requirements of the metal merchant.

Statistics compiled from the fourth viewpoint have probably the most important practical value, but, unfortunately for Canada, represent a fraction only of our metal production.

Statistics from the third viewpoint, showing smelter production, would not completely represent the total metal production of Canada.

Experience in the United States has shown that statistics of mine production, as explained in the second viewpoint, agree fairly closely with statistics of smelter production from the third viewpoint. The former affords a means of crediting production to particular localities, while the latter gives probably a more exact record of metal production.

In Canada, owing to the local smelter production not including all ores shipped, a combination of these two methods of viewing metal statistics would probably give the most satisfactory results.

Besides the considerable correspondence necessitated in connexion with the collection of statistics of mineral production, a good deal of time is occupied in the correspondence and preparation of information for inquirers respecting the mineral industries, and mineral resources of the Dominion.

The card catalogue of mineral occurrences requires a review of all official mining reports, as well as the transactions of mining societies: such as the Canadian Mining Institute, and many others, in order that it may be kept up to date.

It is intended, also, in the immediate future, to proceed with a card catalogue of all mining operators throughout Canada; this being considered much the most convenient method of keeping such lists.

In connexion with the preparation of reports published during the year, due acknowledgment is made of the assistance given by Mr. Howells Frèchette, M.Sc., in the preparation of the Preliminary Report on the Mineral Production of Canada during 1908, published in March, and of the assistance rendered by Mr. Theo. C. Denis, M.E., who prepared the special reports on coal, coke, and peat, petroleum and natural gas, together with other chapters included in the final annual report on mineral production. Mr. John M. Casey—formerly professor of mathematics in Ottawa College—was appointed as assistant to the Division, in June, 1909, and will take special charge of the statistical compilations.

With the appointment of an additional technical officer, provided for, it is hoped that it will be possible to publish our statistical reports much earlier than has been possible under past conditions.

A Preliminary Report on the Mineral Production of Canada during the calendar year 1909, with revised statistics for 1908, has been printed as a separate publication (No. 62), and is reproduced as an appendix.

## REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C., DURING THE YEAR ENDED DECEMBER 31, 1909.

There were 573 deposits of gold bullion, requiring 613 melts and 613 assays (quadruplicate check assays being made in each instance), including the assembling and remelting of the individual deposits, after purchase, into bars weighing about 1,200 troy ounces each, and the assaying of same. The aggregate weight of the deposits before melting was 48,478·60 troy ounces and after melting 47,576·27 troy ounces, showing a loss in melting of 1·8613 per cent. The loss in weight by assaying was 5·63 troy ounces (base and parted silver), the average fineness of the resulting bullion, viz., 47,570·64 troy ounces, being 0·802 gold and 0·178 silver. The net value of the gold and silver contained in deposits was $789,267.94.

A substantial increase is reported of the gold output of the Yukon for the year 1909 as compared with the previous year; very little of same, however, was marketed at this office, there being a decrease of 57,142·79 troy ounces received from the Yukon during the year 1909 as compared with the former year. The greater part of the Yukon gold output is now shipped to San Francisco by registered mail, the transportation charges being the same from Dawson,Y.T., to San Francisco, as from Dawson to Vancouver, B.C. The charges imposed at the different institutions in San Francisco for the purchase of gold bullion are one-eigth of one per cent less on the gross value of the bullion than at this office. If a rebate were allowed of one-eighth of one per cent on the gross value of all bullion from the Yukon deposited at this office on which the Royalty or export tax had been paid, it would be the means of diverting the Yukon gold output to Vancouver; and incidently keep the prestige (a valuable asset, especially if the operations of the Assay Office were of such volume as to warrant weekly or even monthly publication), and trade accompanying the marketing of the gold in this country.

The gold bullion received came from the following sources, viz.:—

| Source. | Deposits. | Weight. Before melting. | Weight. After melting. | Net value. |
|---|---|---|---|---|
| | No. | Ozs. | Ozs. | $ cts. |
| Yukon Territory | 81 | 5,130·36 | 5,003·12 | 83,870 84 |
| British Columbia | 458 | 36,708·91 | 35,970·03 | 602,530 75 |
| Alberta | 6 | 60·99 | 41·74 | 766 77 |
| Alaska | 27 | 6,552·33 | 6,535·49 | 101,605 49 |
| California | 1 | 26·01 | 25·89 | 494 09 |
| | 573 | 18,478·60 | 47,576·27 | 789,267 94 |

| | | |
|---|---|---|
| Weight before melting | 48,478·60 | ounces. |
| Weight after melting | 47,576·27 | " |
| Loss by melting | 902·33 | " |

Loss percentage by melting =1·8613.

## Credits and Disbursements for the Purchase of Gold Bullion and receipts from sale of same during the Year ended December 31, 1909.

| — | $ cts. | $ cts. |
|---|---|---|
| Disbursements for purchase of bullion on hand January 1, 1909, bars Nos. 1295, 1296, 1298, 1299, and 1301 to 1342 inclusive | | 47,731 86 |
| Disbursements for purchase of bullion during year ended December 31, 1909—Cheques Nos. 1343 to 1412 inclusive and Nos. 1 to 548 inclusive—omitting the following Nos. issued in payment for nuggets (Gold Nugget Collection), viz., Nos. 68, 73, 83, 92, 96, 103, 109 to 113 inclusive, 120, 124 to 126 inclusive, 159, 169, 170, 204, 207 to 213 inclusive, 218, 219, 222, 233, 237, 238, 258, 263 to 265 inclusive, 286, 287, 291, 295, 304, 351, and 361 to 363 inclusive | | 789,267 94 |
| Proceeds from sale of bullion during year ended December 31, 1909 | 826,502 08 | |
| Value of bullion on hand December 31, 1909, bars Nos. 524, 530, and 536 to 548 inclusive | 11,169 64 | |
| Difference in favour of this Office | | 671 92 |
| | 837,671 72 | 837,671 72 |
| Unexpended balance, "Letter of Credit", January 1, 1909 | | 21,084 28 |
| Credits established during year ended December 31, 1909 | | 900,000 00 |
| "Letter of Credit" balance written off at close of fiscal year, March 31 | 16,839 59 | |
| Disbursements for purchase of bullion | 789,267 94 | |
| Disbursements for purchase of nuggets (Gold Nugget Collection) | 4,584 71 | |
| Unexpended balance, "Letter of Credit", December 31, 1909 | 110,392 04 | |
| | 921,084 28 | 921,084 28 |

## Contingent Account for Year ended December 31, 1909.

| — | $ cts. | $ cts. |
|---|---|---|
| Unexpended balance, January 1, 1909 | | 140 68 |
| Funds provided per official cheques Nos. 826, 882, 935, 3, 55, 184, 239, 310, 362, 431, 498, and 573 | | 5,250 00 |
| Amount remitted Receiver General, per Draft No. 114, at close of fiscal year, March 31, 1909 | 119 47 | |
| Expenditure during year ended December 31, 1909 | 5,115 70 | |
| Unexpended balance, December 31, 1909 | 155 51 | |
| | 5,390 68 | 5,390 68 |

## Contingent Expenditure for Year ended December 31, 1909.

| | |
|---|---|
| Rent | $2,775 00 |
| Fuel, gas | 265 45 |
| Fuel, coal | 39 00 |
| Light and power | 161 25 |
| Express charges on bullion | 672 06 |
| Express charges on stationery from Ottawa | 6 50 |
| Installation of electric vault protection | 375 00 |
| Electric vault protection service | 300 00 |
| Postage and telegrams | 20 39 |
| Telephones | 67 50 |
| Customs duty, freight, etc., on assayers' and melters' supplies | 22 40 |
| Assayers' and melters' supplies, (purchased locally) | 156 39 |
| Insurance, transportation, and telegrams in connexion with Gold Nugget Collection | 119 00 |
| Sundries | 135 76 |
| | $5,115 70 |

## Proceeds from Residues sold March, 1909.

| | |
|---|---|
| Slag sold to Joseph Mayer & Bros | $183 75 |
| Silver sold to Joseph Mayer & Bros | 45 63 |
| Cornets and residues sold to Assay Office, Seattle | 490 00 |
| 40 empty acid bottles sold to British Columbia Assay and Chemical Supply Co., Ltd | 6 00 |
| 9¼ lbs. mercury sold to British Columbia Assay and Chemical Supply Co., Ltd | 3 70 |
| For melting and rolling into strips, 21 ounces foreign silver coins | 5 00 |
| | $734 08 |

## Residues on Hand December 31, 1909.

| | |
|---|---|
| Slag from melting of bullion | 265 lbs. |
| Granules | 13·24 ounces. |
| Silver | 9·08 " |
| Empty Winchesters | 34 only. |

The following shows the business done by the Assay Office since its establishment:—

| Year. | Number of Deposits. | Weight, (Troy ozs.) | Net value. |
|---|---|---|---|
| | | | $ cts. |
| 1901-2, fiscal | 671 | 69,925·67 | 1,153,014 50 |
| 1902-3 " | 509 | 36,295·69 | 568,888 19 |
| 1903-4 " | 381 | 24,516·36 | 385,152 00 |
| 1904-5 " | 443 | 29,573·73 | 462,939 75 |
| 1905-6 " | 345 | 21,050·83 | 337,820 59 |
| 1906-7, nine months | 269 | 20,695·84 | 336,675 65 |
| 1907-8, fiscal | 482 | 46,540·25 | 751,693 97 |
| 1908, nine months | 590 | 90,175·48 | 1,478,893 74 |
| 1909, calendar | 573 | 48,478·60 | 789,267 94 |

### CHANGES IN STAFF.

Mr. Ross H. Fillion, computer and bookkeeper, resigned May 31, 1909. Mr. G. N. Ford was appointed computer and bookkeeper on June 1, 1909, at a salary of $100 per month, to succeed Mr. R. H. Fillion.

### IMPROVEMENT OF EQUIPMENT.

An electric burglar alarm for protection of the vault door was installed during the month of December, 1908, and connected with the office of the British Columbia District Telegraph and Delivery Company. Electric protection for the walls, roof, and floor of the vault was installed later, viz., during the month of March, 1909, the equipment being so constructed that it can be transferred and applied to another vault of similar size.

### ASSAY OFFICE QUARTERS.

The lease of the Assay Office quarters expired November 30, 1909, and an extension to April 30, 1910, was arranged at an increase of rent from $225 to $300 per month.

Arrangements have been practically completed to prepare part of the ground floor and basement of the old post-office building for the Assay Office.

GOLD NUGGET COLLECTION.

Instructions were received on June 10, 1909, to make a collection of gold nuggets, value not exceeding sum of $10,000, and forward same, properly insured, to R. L. Broadbent, C/o Canadian Exhibition Commission, Alaska-Yukon-Pacific Exposition, Seattle, Wash., U.S.A., disbursements for purchase of the nuggets to be made from 'Letter of Credit.'

One hundred nuggets weighing 259·35 ounces, containing 244·90 ounces bullion and 14·45 ounces matrix, were collected and forwarded as directed, the total sum paid for same being $4,584.71, an average of $17.68 per ounce or $18.72 per ounce for the bullion which they contained, the weight of bullion being determined by specific gravity.

In addition to the above expenditure from 'Letter of Credit,' the sum of $119 was paid from the 'Contingent Account' for insurance, transportation, and telegrams, making a total of $4,703.71.

Mr. William Hutchison, Canadian Exhibition Commissioner, wrote from Seattle on October 13, 1909, stating that he had been requested by Hon. Sydney A. Fisher, B.A., Minister of Agriculture, to secure these nuggets for exhibition purposes and that he (Mr. Hutchison) would, therefore, take over the nuggets and be responsible for them until arrangements were made with the Department of Mines.

The following is a summary showing the source, weights, etc., of the nuggets, viz:—

| Mining District. | Number of nuggets. | Weight of Matrix. | Weight of Bullion. | Gross Weight. | Amount paid. |
|---|---|---|---|---|---|
| | | Ozs. | Ozs. | Ozs. | $ cts. |
| Atlin, B.C. | 40 | 6·35 | 142·99 | 149·34 | 2,573 82 |
| Cariboo, B.C. | 53 | 6·10 | 82·53 | 88·63 | 1,645 87 |
| Fort Steele, B.C. | 3 | 0·91 | 8·09 | 9·00 | 161 80 |
| Skeena, B.C. | 3 | 0·38 | 5·30 | 5·68 | 95 40 |
| Yukon Territory | 1 | 0·71 | 5·99 | 6·70 | 107 82 |
| | 100 | 14·45 | 244·90 | 259·35 | 4,584 71 |

G. MIDDLETON,
*Manager.*

December 31, 1909.

G. MIDDLETON, Esq.,
Manager,
Dominion of Canada Assay Office,
Vancouver, B.C.

SIR,—The following is the list of the assayers' supplies on hand, viz.:—

| | |
|---|---|
| Silver nitrate crystals | 1 oz. |
| Calcic chloride | ⅔ lb. |
| Copper wire | ½ spool. |
| Lead foil, C.P. | 100 lbs. |
| Cupels | about 5,000 |
| Nitric acid | 10 Winchesters. |

| | |
|---|---|
| Hydrochloric acid | 1 Winchester. |
| Sulphuric acid | ¾ " |
| Ammonia | 1 " |
| Zinc (Mossy) C.P. | ½ lb. |
| Lead (Granulated) | 6 lbs. |
| Scorifiers, 4" | 9 |
| " 2¼" | 55 |
| Spare muffles | 16 |
| " doors | 6 |
| " supports | 4 |
| " back stops | 4 |
| " plugs | 17 |
| Litharge | 25 lbs. |
| Bone ash ..about | 20 " |
| Gold cornets | 8·16 ozs. |
| Gold proof | 5·92 " |
| Silver | 60·19 " |
| Silver proof | 0·49 ozs. |
| Fireclay ..about | 25 lbs. |

Yours obediently,

J. B. FARQUHAR,
*Chief Assayer.*

December 31, 1909.

G. MIDDLETON, Esq.,
Manager,
Dominion of Canada Assay Office,
Vancouver, B.C.

SIR,—I beg to inform you that we have on hand in the Melting Department the following supplies, viz.:—

3 sets of linings with supports and covers complete, for No. 1 furnace.
3 " " " " No. 2 "
3 " " " " No. 4½ "
4 " " " " No. 7 "
4 Graphite crucibles, No. 10
60 " " No. 16.
20 " " No. 30.
28 " " No. 40.
55 " " marked
2 Crucible covers, No. 50.
2 " " No. 16.
2 Graphite stirrers.
2 Wire brushes.
4 lbs. Pot. Nitrate.
35 lbs. Carb. Soda.
70 lbs. Borax Glass.

Your obedient servant,

D. ROBINSON,
*Chief Melter.*

## ACCOUNTANT'S STATEMENT.

The following is a statement of difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office from April 1, 1908, to March 31, 1909.

| | |
|---|---|
| Paid for bullion at Dominion of Canada Assay Office, Vancouver | $ 1,583,166 57 |
| Received for bars from United States Assay Office, Seattle | 1,584,058 94 |
| Difference in favour of Dominion of Canada Assay Office | 892 37 |

### STATEMENT OF DEPOSITS OF GOLD AND EARNINGS.

| | | |
|---|---|---|
| Deposits of Gold | | 1,583,166 57 |
| *Earnings*— | | |
| Value of 89 ozs. silver sold Jos. Mayer & Bros | $ 45 63 | |
| " cornets and residue sold United States Assay Office | 490 00 | |
| " sweeps sold Jos. Mayer & Bros | 183 75 | |
| " 40 acid bottles and 9 lbs. mercury sold B.C. Assay & Chemical Supply Co | 9 70 | |
| For melting 21 ozs. silver coins | 5 00 | |
| | $ 734 08 | |
| Difference between amount paid and received for bullion | 892 37 | |
| | $ 1,626 45 | |

The following is a statement of appropriation, receipts, and expenditure for the year ended March 31, 1909, and shows the unexpended balance to be $11,788.55:—

| — | Appropriation. | Expenditure. |
|---|---|---|
| | $ cts. | $ cts. |
| Appropriation, 1908-9 | 26,000 00 | |
| Receipts per the foregoing statement | 734 08 | |
| Difference between amount paid and received for bullion | 892 37 | |
| Rent | | 2,550 00 |
| Fuel | | 340 86 |
| Power and light | | 172 93 |
| Postage and telegrams | | 108 70 |
| Telephone | | 66 00 |
| Express charges | | 1,288 60 |
| Assayers supplies | | 291 81 |
| Printing and stationery | | 49 01 |
| Premium and Fidelity bonds | | 590 16 |
| Electric burglar alarm service | | 625 00 |
| Contingencies | | 118 83 |
| *Wages*— | | |
| G. Middleton | | 2,500 00 |
| J. B. Farquhar | | 1,800 00 |
| D. Robinson | | 1,700 00 |
| A. Kaye | | 1,500 00 |
| G. B. Palmer | | 900 00 |
| R. Fillion | | 660 48 |
| P. W. Thomas | | 233 87 |
| E. Tierney | | 341 65 |
| Balance unexpended | | 11,788 55 |
| | 27,626 45 | 27,626 45 |

Unexpended balance, March 31, 1909, lapsed, $11,788.55.

(Signed) JOHN MARSHALL,
*Accountant, Department of Mines.*

# FIELD WORK

## PRELIMINARY REPORTS.

### ON THE MOLYBDENUM ORES OF CANADA

*T. L. Walker, M.A., Ph.D.*

In accordance with instructions I spent a little over two months examining some of the chief deposits of molybdenite in the Maritime Provinces and Quebec.

In recent years there has been a relatively good market for ores of molybdenum owing to the properties imparted to steel by the introduction of a small proportion of molybdenum. The resulting steel is much in demand for tool steel owing to its retaining its temper when heated to a high degree. Similar properties are obtained by the use of tungsten, but to obtain the same result about twice as much tungsten is necessary.

The ore supply has been very irregular, and at times not sufficient to meet the demand. The price has risen, until now molybdenite 92 per cent pure $MoS_2$, free from copper arsenic and bismuth, is valued at from $550 to $600 per ton.

The chief ores are molybdenite—$MoS_2$—and wulfenite—$PbMoO_4$. Only the former is known to occur in promising deposits in Canada. Molybdenite is usually found in or near granite or gneissoid rocks. Since eastern Canada contains very extensive areas of these rocks it seems reasonable to expect that these regions should supply at least a part of the molybdenum required for metallurgical purposes. Up to the present nothing beyond initial prospecting has been attempted. It is hoped that a systematic examination of the leading granite areas and molybdenite deposits may contribute towards the development of a molybdenum industry in Canada.

In Nova Scotia I visited nearly all the known deposits—near Jordan falls, Shelburne county; New Ross, Lunenburg county; Glengarry and Gabarus, in Cape Breton. These properties have not been developed.

In New Brunswick molybdenite is known to occur, but no attempt has so far been made to develop the deposits.

In Quebec where the areas of granite and gneiss are very extensive, a great many occurrences of molybdenite have been recorded, but none of the properties have been fully explored. I examined some of the deposits at Romaine and Peaster bays, on the north shore of the Gulf of St. Lawrence, and also some of those to the north of the Ottawa river in Alleyn, Egan, Aldridge, and Calumet townships. The only place where explorations were being carried on was at Romaine, where Lt.-Col. John Carson, of Montreal, and associates had a party of about ten men employed.

While working in New Brunswick near the Maine border I paid a visit to the adjacent molybdenum fields in the State of Maine. There the molybdenite is scattered widely through a granite rock, which seems to be available in considerable quantity, so that the ore could be quarried. At Cooper, Me., some years ago considerable ore was quarried and treated by crushing and dry concentration in a mill specially designed for the purpose. For many years no work had been done, though there were reports of proposed re-opening of the quarry and mill.

At Catharine Hill, Me., ore of a similar type is available, but nothing has been done beyond a little prospecting and preliminary development.

Few of the Canadian deposits examined appear to be of the type presented at Cooper and Catharine Hill. It is hoped that the information gathered at Cooper and Catharine Hill may be of value in the preparation of a report on Canadian molybdenum deposits.

Four chief types of deposit have been observed in my examination of the molybdenite deposits of Quebec and the Maritime Provinces. The ore mineral occurs:—

(1.) In white veins of quartz;

(2.) In very coarse granite pegmatite;

(3.) In green pyroxene rock;

(4.) Associated with copper ores.

I am at present engaged in an examination of the material collected, with a view to preparing a bulletin on molybdenum ores in Canada.

# THE MAGNETIC CONCENTRATION OF IRON AND COPPER NICKEL ORES.

*Geo. C. Mackenzie, B.Sc.*

I beg to submit herewith a preliminary report upon the work now in progress, dealing with the magnetic concentration of two iron ores, one each from the Provinces of Quebec and New Brunswick; also the separation of an Ontario copper nickel ore.

After consultation with you regarding the iron areas to be experimented upon, my instructions were to confine the work for the winter of 1909-1910 to the concentration of the high sulphur ores of the Bristol mines, situated on lots 21 and 22, range II, township of Bristol, county of Pontiac, in the Province of Quebec, and to the leaner and more siliceous material found associated with the merchantable ore of the Bathurst mines of the Canada Iron Corporation, Limited, situated on lot 12, range XVII, township of Bathurst, county of Gloucester, in the Province of New Brunswick.

With your approval I completed arrangements with the authorities of the School of Mining at Kingston, Ontario, for the temporary rental of their mining laboratory: which contains the necessary crushing, grinding, classifying, and magnetic separating machinery required for experimental work of this character. Concentration tests will be carried out in this laboratory until such time as the ore dressing plant for the Mines Branch, now building in Ottawa, is ready for occupation.

On September 22, 1909, I left Ottawa for the Bristol mines, and upon arrival found Mr. Einar Lindeman, of the Mines Branch, engaged in making a magnetometer survey of the deposits. Mr. Lindeman very kindly accompanied me over the property, giving me the benefit of his field experience, and I was much impressed with the result of his work, indicating, as it did, the presence of large bodies of magnetic iron ore. After an examination of the property it was apparent that much difficulty would be experienced in the selection of a sample representative of the run of mine ore. All of the old pits and open workings being filled with water prevented any attempt being made to secure a large sample of the ore *in situ*. Upon examination of the dumps it was discovered that such ore as they contained was badly weathered. However, it was found that by removing the surface ore and taking that portion underneath which had been protected somewhat from the weather, a sample could be obtained that would approximately represent the condition of the ore as originally mined. In selecting the samples larger pieces of rock were cobbed out, but no attempt was made to select pieces of ore free from sulphur, as it was intended to show that subsequent magnetic separation would eliminate the sulphur to a large extent.

Shipment No. 1 was taken from the mine dump near the engine house at No. 1 incline shaft.[1]

Shipment No. 2 was taken from a small dump on the Killroy farm, situated 550 feet southeast of No. 1 shaft. The ore on the dump was mined some years ago from an open pit marked No. 2[2] on Mr. Lindeman's map of the property, which accompanies this report. This dump was found to be more badly weathered than that from which the first shipment was taken, and considerable picking over and sorting was necessary before a sample could be obtained that was at all representative.

Both samples were bagged and shipped to the mining laboratory of the School of Mining at Kingston, Ont.

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1 *See* Mr. Lindeman's map of the Bristol Mines, accompanying this report.
2 Ibid.

On October 6 I left Ottawa for the Bathurst mines of the Canada Iron Corporation, Limited. On my way through Montreal I called upon Mr. John T. Drummond, manager of mines and furnaces for the Corporation, who received me courteously and gave me a letter of introduction to the mine superintendent at Austin brook. The mines are reached by taking the Intercolonial railway to Bathurst station, and from thence driving a distance of twenty-six miles to the junction of Austin brook with the Nipisiguit river.

Mr. T. T. Fulton, the mines superintendent, to whom thanks are due for his kind hospitality during my visit, accompanied me over the two deposits of ore so far being exploited. At the time of my visit mining operations were confined to the most northerly part of No. 1 deposit, which outcrops on the south side of Austin brook, in the form of a steep bluff about 80 feet high. The width of the ore body at this point is approximately 100 feet. Mining consists of open-cut bench work on the face of the bluff, the broken ore being conveyed to the end of a trestle and dumped on the ground level with a railway siding now building. From this dump it will be loaded on cars and shipped to a junction on the Intercolonial railway via a branch line of railway now under construction.

The ore on the face of this bluff, more particularly on the western side, is distinctly of merchantable grade, being free from much interbanded silica; hand specimens exhibit no sign of sulphides. On top of the bluff and about 100 feet back from the face, the ore contains more interbanded silica, with a little iron pyrites. This interbanded material does not, however, extend across the width of the deposit, the banded material being more in evidence on the east side, diminishing gradually towards the western limit. It is evident that much of this banded material must be cobbed out, if shipments are to be made containing in the neighbourhood of 55 per cent of iron, and as the rejected portion will in time amount to a considerable tonnage and contain between 30 and 40 per cent of iron, it is a matter of some importance to investigate the possibility of recovering this iron by means of magnetic separation.

A sample of this banded material was, therefore, taken from No. I deposit, care being taken to select only that portion which would of necessity be rejected in the process of hand cobbing. This sample was marked Shipment No. 1.

Deposit No. II, situated on the north side of Austin brook, is not as large as No. I, having a width of approximately 30 feet. The bands of siliceous material are, however, not so wide or so numerous in this deposit. The sample taken from this outcrop was selected with the same care as that taken from No. I deposit, but for reasons just stated, it is probably higher in iron than the other.

Both samples were sacked and shipped to the School of Mining at Kingston, Ont.

## CONCENTRATION TESTS WITH BRISTOL ORE.

*Shipment No. 1.*—This shipment consisted of a fairly coarse-grained magnetite in a gangue hornblende, feldspar, calcite, and free quartz. Iron pyrites is present in considerable quantity, not finely disseminated, but occurring in stringers and nodular masses throughout the ore.

Analysis of this shipment so far completed is as follows:—

*General sample A—*

| | | |
|---|---|---|
| Iron | 53·500 | per cent. |
| Insoluble residue | 17·460 | " |
| Sulphur | 3·620 | " |
| Phosphorus | 0·011 | " |

The net weight of this shipment was 3,758 pounds. The ore was broken to $\frac{3}{4}$ inch in a Blake crusher, thence fed to Cornish rolls, crushing to $\frac{1}{8}$ inch, the discharge from the rolls passing over a 6 mesh impact screen; oversize being returned to the

rolls, until all of the ore had been reduced to the required size. The crushed ore was then piled on a sampling floor, and a sample selected for analysis by the split shovel method. This sample was marked 'General Sample A,' and represented the shipment as received.

Approximately one-half of the shipment was taken for wet separation, the remaining half to be concentrated by the ordinary dry method, the two portions weighing 1,922 and 1,836 pounds respectively.

That half of the shipment reserved for wet separation was then split into three equal portions; the first portion being ground into a Krupp ball mill to a fineness of 10 mesh, the second ground to a fineness of 20 mesh, and the third to a fineness of 40 mesh. Each of these three portions was then separated independently by the Gröndal magnetic separator. The results obtained afford comparisons of the efficiency of separation with the different sizes of the same material.

The following figures illustrate the results obtained after wet separation, with the different sizes of Bristol No. 1 Shipment:—

| Size of Feed. | Weight of Feed. | Concentrates. | | Tailings. | | Loss. | |
|---|---|---|---|---|---|---|---|
| | | Weight. | Per Cent. | Weight. | Per Cent. | Weight. | Per Cent. |
| | Pounds. | Pounds. | | Pounds. | | Pounds. | |
| Through 40 mesh.... | 648 | 504 | 77·77 | 132 | 20·37 | 12 | 1·86 |
| " 20 " .... | 535 | 424 | 79·25 | 101 | 18·87 | 10 | 1·88 |
| " 10 " .... | 639 | 532 | 82·25 | 100 | 15·64 | 7 | 1·11 |

Analyses of the above concentrates and tailings have not been completed, hence full data cannot be given. After the above separation the tailings in each case were found to contain a large proportion of sulphides, indicating that the original sulphur contents of the crude had been reduced considerably in the concentrates.

That portion of the shipment reserved for dry separation, weighing 1,836 pounds, was then sized over impact screens; the object of this sizing process being to assemble particles of the same size irrespective of specific gravity, the practical effect of which is to increase the efficiency of the subsequent separation process. The screens selected for this sizing process were as follows: 40 mesh, yielding particles finer than 40 mesh; 20 mesh, yielding particles larger than 40 mesh, and finer than 20; 10 mesh, yielding particles larger than 20 mesh and finer than 10, and 6 mesh, yielding the final product consisting of particles larger than 10 mesh and finer than 6 mesh. Each of the sized products was then piled on the sampling floor and a sample taken for analysis by the split shovel method, these samples being marked Nos. 1, 2, 3, 4, for 40, 20, 10, and 6 mesh sizes respectively. A summation of the analysis of these four different sizes should approximate with the analysis of the General Sample A, affording a check upon the whole.

The sizing process by the impact screens gave the following figures:—

| Size of Material. | Weight in Pounds. | Per Cent. |
|---|---|---|
| Through 40 mesh.................................. | 714 | 38·85 |
| " 20 and on 40 mesh.......................... | 355 | 19·35 |
| " 10 " 20 " ........................ | 378 | 20·60 |
| " 6 " 10 " ........................ | 389 | 21·20 |

Neither analysis nor results of dry separation of the above material can be given at this date, this portion of the work not having been finished.

*Shipment No. 2.*—This ore differs radically from No. 1 in that it contains considerable hematite. The crystallization is finer, and iron pyrites, which occurs as fine stringers and splashes throughout the ore, is more evenly distributed. The gangue of this ore contains more calcite than the gangue of No. 1, and the percentage of insoluble matter is considerably lower.

Analysis of this ore so far completed is as follows:—

*General Sample A*—

| | |
|---|---|
| Iron | 51·830 |
| Insoluble residues | 9·970 |
| Sulphur | 2·790 |
| Phosphorus | 0·008 |

The net weight of this shipment was 4,323 pounds.

The ore after being broken to ¾ inch in the Blake crusher, received exactly the same treatment as that given Shipment No. 1. The General Sample A, which was selected after crushing to ⅙ inch, and marked 'Bristol Mines, No. 2,' represents the shipment as received.

The ore was then divided into two portions for wet and dry separation, the portion for wet separation weighing 1,904 pounds. The following figures illustrate the results obtained after wet separation, with the three different sizes of No. 2 ore:—

| Size of Feed. | Weight of Feed. | Concentrates. | | Tailings. | | Loss. | |
|---|---|---|---|---|---|---|---|
| | | Weight. | Per Cent. | Weight. | Per Cent. | Weight. | Per Cent. |
| | Pounds. | Pounds. | | Pounds. | | Pounds. | |
| Through 40 mesh.... | 664 | 472 | 71·08 | 172 | 25·90 | 20 | 3·02 |
| " 20 " .... | 622 | 392 | 63·02 | 199 | 31·99 | 31 | 4·99 |
| " 10 " .... | 618 | 346 | 55·98 | 229 | 37·05 | 43 | 6·97 |

Comparing the above figures with results obtained from separation of No. 1 ore, it is apparent that the percentage of concentrates is much lower for No. 2 ore. This is explained by the fact that No. 2 ore in the crude contained a considerable quantity of hematite, which being non-magnetic entered the tailings. This hematite has no doubt originated largely from oxidation of the iron pyrites contained in the ore, the dump from which this shipment was taken having been exposed to weathering agencies for many years. No difficulty was experienced with the elimination of sulphides, these minerals being found to enter the tailings readily.

The portion of No. 2 Shipment reserved for dry separation—weighing 2,319 pounds—was then sized for dry separation, on the impact screens. The following figures give the percentages and weights of the four different sizes, after preliminary crushing to ⅙ inch.

| Size of Material. | Weight in Pounds. | Per Cent. |
|---|---|---|
| Through 40 mesh | 866 | 37·40 |
| " 20 and on 40 mesh | 303 | 13·08 |
| " 10 " 20 " | 525 | 22·64 |
| " 6 " 10 " | 625 | 26·88 |

Samples of the above sized material were selected by the split shovel. Neither analyses nor results of dry separation have as yet been completed.

CONCENTRATION TESTS WITH THE BATHURST ORE.

*Shipment No. 1.*—This ore (if such it may be called) consists of cryptocrystalline magnetite and hematite interbanded with extremely fine-grained siliceous material consisting almost entirely of quartz. The bands of siliceous material alternating with the bands of magnetite vary from ½ to 1 inch in thickness, and impart to the ore a laminated structure. Iron pyrites occurs with this banded ore to some extent, but is present only in small amount. Analyses of this shipment have not yet been completed.

The net weight of this shipment was 3,411 pounds. The crude ore being broken to ¾ inch in the Blake crusher, was then crushed to ⅙ inch in Cornish rolls, oversize being returned until all had passed the 6 inch mesh screen. The ore was then sampled with the split shovel, and this sample marked Bathurst General Sample A. The shipment was then divided into two portions for wet and dry separation, weighing respectively 1,484 and 1,927 pounds. The portion for wet separation was then subdivided into approximately three equal parts; the first part being ground in the Krupp ball mill to a fineness of 60 mesh, the second to a fineness of 40 mesh, and the third to a fineness of 20 mesh. Separation tests with these three sizes have not yet been completed, hence no figures can be given.

The remaining portion of the shipment for dry separation was then sized by passing the ore over the impact screens. The following figures give the weights and percentages of the different sizes, after preliminary crushing to ⅙ inch.

| Size of Material. | Weight in Pounds. | Per Cent. |
|---|---|---|
| Through 40 mesh | 447 | 23·19 |
| Through 20 and on 40 mesh | 124 | 6·43 |
| Through 10 and on 20 mesh | 416 | 21·59 |
| Through 6 and on 10 mesh | 940 | 48·78 |

Neither analyses nor separation of the dry material have been accomplished as yet.

*Shipment No. 2.*—This ore is similar in appearance to No. 1, possessing the same cryptocrystalline banded structure. The siliceous bands are, however, less numerous, therefore this shipment will, it is expected, be higher in iron than No. 1.

No analyses of this ore have been completed. This shipment, weighing 3,557 pounds, received exactly the same treatment as that given to No. 1. The ore, after a preliminary breaking to ¾ inch in the Blake crusher, was crushed to ⅙ inch in Cornish rolls, and then sampled.

After selection of the general sample A, the ore was then divided into two portions for wet and dry separation, weighing respectively 1,433 and 2,124 pounds. The portion for wet separation was then split into three parts, the first part being ground to 60 mesh, the second to 40 mesh, and the third to 20 mesh, each portion to be separated independently. Wet separation of this material has not yet been accomplished.

The portion for dry concentration, after the sizing treatment by the impact screens, gave the following figures:—

| Size of Material. | Weight in Pounds. | Per Cent. |
|---|---|---|
| Through 40 mesh | 437 | 20·57 |
| Through 20 and on 40 mesh | 178 | 8·38 |
| Through 10 and on 20 mesh | 637 | 29·99 |
| Through 6 and on 10 mesh | 872 | 41·05 |

Neither anayses nor separation of the dry material have been accomplished as yet.

MAGNETIC SEPARATION OF A COPPER NICKEL ORE.

On November 2, I received a letter from you instructing me that you were sending one ton of copper nickel ore in the lump, and on November 8, you advised me of a second shipment of copper nickel ore, consisting of fines.

The first shipment (lump ore) was received on November 18, 1909. The second shipment, consisting of fines, has not yet been received.

Your letter of instructions regarding this ore was that I should experiment for the production of magnetic heads, free from copper, the separation process at the same time yielding a tailings product, free from nickel.

The shipment of lump ore, as received, weighed 1,268 pounds, and consisted of copper pyrites and pyrrhotite in a gangue of dark coloured eruptive rock. The ore was first broken in the Blake crusher to ¾ inch, and then reduced to ¼ inch size by Cornish rolls, the oversize being returned from a ¼ inch impact screen. The crushed ore was then piled on the sampling floor and thoroughly mixed by repeated conning, after which it was sampled by means of the split shovel.

Analysis of this sample for copper and nickel gave the following result:—

| | Per cent. |
|---|---|
| Copper | 3·49 |
| Nickel | 4·56 |

The crushed ore was then subdivided into three parts, the first portion being ground in the Krupp ball mill to a fineness of 60 mesh, the second to a fineness of 40, and the third to a fineness of 20 mesh. Each portion was then treated independently by the magnetic separator, the idea of so treating the three portions being to gain information as regards the behaviour of the copper and nickel minerals when concentrated at different sizes.

Wet magnetic separation after the Gröndal system was employed throughout this work, the exciting current being fixed at 5 amperes.

Three products were obtained from each separation of this ore; (1) magnetic heads which were caught in a spitzkasten settling box; (2) slimes from the heads, these being in a fine state of subdivision, floated off from the spitzkasten and were caught in a second settling box of larger area; (3) tailings which were caught in a second pair of settling boxes. After the ore had passed through the separator, each of the above tanks was allowed to settle, the water drained off, and the several products collected, dried, and weighed.

Concentration of the 60 mesh material yielded the following results, after the first pass of the original crude:—

| | Copper, per cent. | Nickel, per cent. |
|---|---|---|
| Heads | 1·96 | 4·02 |
| Tails | 5·23 | 5·58 |

It is apparent from the above analysis that a considerable portion of the nickel-bearing minerals are either feebly or non-magnetic. Hence, the tails were re-passed through the separator twice, in an effort to lower their nickel contents; and in order that feebly magnetic minerals should be attracted, the exciting coils were changed from series to parallel, increasing the current from 5 to 20 amperes. The result of this re-concentration of the first tailings is illustrated by the following analyses:—

| | Copper, per cent. | Nickel, per cent. |
|---|---|---|
| Heads | 5·16 | 5·59 |
| Tails | 6·79 | 5·28 |

The above results exhibit conclusive proof that a clean separation of the nickle-bearing minerals from the copper pyrites cannot be accomplished by the Gröndal wet method of concentration. It would no doubt be possible to lower the nickel contents of the tailings by passing them over a high tension machine such as the Wetherill magnetic separator; but as the Wetherill machine operates on dry material only, the heads product from such a separation process would contain considerable copper, because small particles of copper pyrites would undoubtedly enter the heads through the agency of mechanical entanglement.

Complete results of concentration of the 60 mesh material are given in the following table; the magnetic portion from the first operation being called heads, the magnetic portion from the re-concentration of the tailings being termed seconds, and the non-magnetic portion from this re-concentration being termed tails.

CONCENTRATION OF 60 MESH: COPPER NICKEL ORE.

| Crude Ore. | | | Heads. | | | | Slime. | | | | Seconds. | | | | Tails. | | | | Loss. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. |
| Lbs. | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | |
| 393 | 3·49 | 4·56 | 215·5 | 54·83 | 1·96 | 4·02 | 16·5 | 4·19 | 4·49 | 3·69 | 86 | 21·89 | 5·16 | 5·59 | 49 | 12·47 | 6·79 | 5·28 | 16 | 4·07 |

NOTE.—Ten pounds of the tailings from the first concentration were taken for sample; this amount equals 2·54 per cent of the weight of original crude.

CONCENTRATION OF THE 40 MESH SIZE.

After the first pass of this material through the separator analysis of the heads and tails gave the following results:—

| | Copper, per cent. | Nickel, per cent. |
|---|---|---|
| Heads.. .. .. .. .. .. .. .. .. .. .. .. .. .. | 1·80 | 4·22 |
| Tails.. .. .. .. .. .. .. .. .. .. .. .. .. .. | 6·09 | 5·39 |

The tailings from the above operation were then reconcentrated, with the machine in parallel, being passed twice, with the following results:—

| | Copper, per cent. | Nickel, per cent. |
|---|---|---|
| Heads.. .. .. .. .. .. .. .. .. .. .. .. .. .. | 5·08 | 5·68 |
| Tails.. .. .. .. .. .. .. .. .. .. .. .. .. .. | 7·44 | 5·68 |

The above results tally approximately with the figures obtained after separation of the 60 mesh material, furnishing additional proof that a large proportion of the nickel-bearing minerals are feebly magnetic. Complete results of concentration of this 40 mesh material are tabulated below, the first magnetic portion taken out being termed heads, the second magnetic portion being termed seconds, and the final non-magnetic residue being called tails.

## CONCENTRATION OF 40 MESH : COPPER NICKEL ORE.

| Crude Ore. | | | Heads. | | | | Slime. | | | | Seconds. | | | | Tails. | | | | Loss. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. |
| Lbs. | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | |
| 348 | 3·49 | 4·56 | 206·5 | 59·34 | 1·80 | 4·22 | 12·5 | 3·59 | 4·37 | 3·96 | 59 | 16·95 | 5·08 | 5·68 | 53 | 15·23 | 7·44 | 4·94 | 10·0 | 2·87 |

NOTE.—Seven pounds of the tailings from the first concentration were taken for sample; this portion equals 2·01 per cent of the weight of original crude.

### CONCENTRATION OF THE 20 MESH SIZE.

The concentration of the 60 and 40 mesh sizes previously described having shown the impracticability of recovering in the magnetic heads more than approximately 50 per cent of the original nickel content, it was decided that the older phase of the problem, *i.e.,* the production of magnetic heads free from copper, should receive its due share of attention.

A glance at the analyses of the heads products from concentration of the 60 and 40 mesh sizes, will show that they contain over 30 per cent of the copper contained in the original crude. This fact deserves some explanation. Copper pyrites when pulverized to a fine state of subdivision has a marked tendency to slime, and when water is used as a carrying medium for this slime, the mineral in fine, scaly particles will float on the surface, due to a surface tension of the liquid. Now in the Gröndal system of magnetic separation the various mineral particles are brought into a magnetic field by a stream of water flowing over a dam or bridge wall, situated immediately below the electro-magnets; the mineral particles being held freely in suspension by the water, the magnetic portion is drawn out towards the magnetic field, the non-magnetic portion escaping as tailings. It will be understood then that in this particular problem the fine copper slimes floating on the surface of the water will adhere to the particles of pyrrhotite as they are lifted through the surface of the water towards the magnetic field.

From the foregoing remarks it would appear that a solution of this problem would be realized if in the preparation of the ore for concentration, precautions were taken to avoid an excess of slime, viz., by the use of crushing machinery yielding a more granular product; or by the elimination of slimes from the pulp before concentration is attempted, using hydraulic classifiers. This particular phase of the problem will be dealt with at greater length in a more exhaustive report.

In concentration of the 20 mesh material an attempt was made to lower the copper contents of the heads product by adjustment of the separator. The only alteration seemingly consistent with the foregoing remarks, appeared to be a reduction of the exciting current, which would result in a lower percentage of magnetic heads recovered, but with a corresponding reduction of their copper content. The exciting current was therefore reduced from 5 to 3 amperes, and after the first pass of this 20 mesh material, analyses of the heads and tails gave the following results:—

| | Copper, per cent. | Nickel, per cent. |
|---|---|---|
| Heads . . . . . . . . . . . . . . . . . . . . . . . . . | 0·53 | 3·62 |
| Tails. . . . . . . . . . . . . . . . . . . . . . . . . . | 5·25 | 3·58 |

The tailings from the above were then re-concentrated with the machine in parallel, using 20 amperes. Analyses of the resulting heads and tails gave the following figures:—

| | Copper, per cent. | Nickel, per cent. |
|---|---|---|
| Heads | 5·01 | 5·45 |
| Tails | 6·90 | 4·49 |

Complete results of the concentration of the 20 mesh material are tabulated below, the first magnetic portion being termed heads, the second magnetic portion being termed seconds, and the final non-magnetic portion being termed tails.

CONCENTRATION OF 20 MESH: COPPER NICKEL ORE.

| Crude Ore. | | | Heads. | | | | Slime. | | | | Seconds. | | | | Tails. | | | | Loss. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. | Analysis. | | Weight. | Per cent. |
| Lbs. | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | | % Cu. | % Ni. | Lbs. | |
| 368·5 | 3·49 | 4·56 | 145·5 | 39·48 | 0·53 | 3·68 | 10·5 | 2·85 | 4·15 | 3·62 | 131 | 35·55 | 5·01 | 5·45 | 56 | 15·17 | 6·90 | 4·49 | 9 | 2·44 |

NOTE.—Sixteen and a half pounds of the tailings from the first concentration were taken for sample; this amount equals 4·48 per cent of the weight of original crude.

Further experimental work looking to the production of magnetic heads free from copper will be undertaken and the results published in a later report. This work will probably consist of a re-treatment of the different sizes of magnetic heads in hydraulic classifiers, and subsequent magnetic separation of the classified material.

The analysis, I made from samples dried at 105°C. for one hour.

# INVESTIGATION OF SOME MANGANESE ORE DEPOSITS IN NOVA SCOTIA AND NEW BRUNSWICK.

*Theo. C. Denis, M.E.*

The manganese industry of Canada has been dormant for nearly twenty years, although previous to that time it was comparatively active. A short investigation as to the reasons for this cessation of work was made during the fall of 1909, and the following notes are the result of a visit to the principal manganese-bearing districts in the Provinces of Nova Scotia and New Brunswick.

The ores of manganese extracted from deposits in the Maritime Provinces, during the period of activity of the mines, were mainly pyrolusite, manganite, and psilomelane, all of exceptional purity, and high grade; although a deposit of wad or bog manganese was also worked for a short time. The ores were shipped mainly to Boston and New York, where they were used in the manufacture of chemical products; in the manufacture of glass, in the production of oxygen, etc. Very high prices were obtained for these ores: some shipments from Tennycape, Nova Scotia, having realized as much as $125 a ton, and a small quantity having even been sold at $140 a ton. None of these high grade ores were sold at less than $45 to $50; but some of lower grade were shipped to steel works as blast furnace ore. The preparation at the mines was mainly done by hand cobbing.

During the last season the following deposits were visited: in Hants county, Nova Scotia, the Tennycape mines, the Parker mine, and the Walton deposits; in Kings county, New Brunswick, the Jordan Mountain mine, the Markhamville deposits; and in Albert county of the same Province, the Shepody Mountain mine, and the Dawson Settlement deposits.

*Tennycape Mines.*—These workings are situated one mile and a quarter, in a straight line, to the southeast of Tennycape post-office, or slightly over two miles by the road. Schooners can be loaded at the mouth of Tennycape river near the post-office. The nearest railway station is at present Kennetcook—some 13 miles distant—on the Dominion Atlantic Railway branch, between Truro and Windsor.

The manganese deposits, according to Mr. Hugh Fletcher's geological map of the district, are found at the junction of the Devonian shales and sandstones, and the overlying Carboniferous limestones and dolomites. The ore, however, is mostly found in the limestone, which is highly magnesian, and the shales and sandstones form the floor of the workings. The general strike of the manganese formation is 20° south of east (astronomically) and the average dip about 30° south. The ore was found in the dolomitic rock, in very irregular masses, varying in size from small nodules of a few inches, to pockets, the largest of which is said to have yielded about one thousand tons of good ore. From these nodules and pockets, veins and fissures radiate—more or less filled with manganese ore—which, in places, present a net work crossing the rock in all directions.

The workings consist of a long open-cut, 500 feet in length, 40 to 60 feet wide; and one main shaft, sunk at a spot 125 feet to the south of the edge of the main cut, and reaching the floor of the manganiferous rocks at a depth of 160 feet. From the bottom of the open-cut a shallow shaft was sunk, and a long tunnel of some 200 feet or more was driven, for the purpose of draining the mine to the low ground lying to the south of the deposit. There are also other shafts and pits, put down mainly for exploratory purposes.

As very little work has been done on this property since 1896, the workings are in bad shape, and thus did not allow of thorough examination as to the possibilities of the mine in case of resumption of work. However, from all the information which could be gathered, it would appear that the manganese ore is distributed very unevenly in the rock. From this fact it would seem unwarranted to go to great expense installing costly mining and concentrating machinery, since from the very nature of the deposits, it would be difficult to keep development work and blocking out the ore very much in advance of the actual mining.

Immediately to the west of the main excavation, an open-cut was made a few years ago, to test the continuity of the manganiferous formation in that direction. The rock uncovered here showed a reticulating network of small stringers, but no large pockets were struck.

Work on the Tennycape deposits was begun about 1860: and although it is difficult to get accurate figures of the total tonnage of ore which they yielded it is probably in the vicinity of 3,000 tons.

There are at the mine large dumps of refuse, which contain an appreciable proportion of manganese ore. The owners of the property are at present looking into the possibility of working over these dumps, and it is possible that a considerable quantity of manganese ore could be recovered at a cost which might be profitable.

*Parker Mine.*—The manganese deposit known as the Parker mine is situated three-quarters of a mile directly north of the Tennycape mine, in a small outlier of Carboniferous limestone detached from the main development, and completely surrounded by Devonian rocks. The workings consist of an excavation from which, according to different authorities, from 20 to 100 tons of good pyrolusite are said to have been mined and shipped in the early eighties. It was from this deposit that ore was extracted which sold for $140 a ton on the Boston market.

The pit is full of water and nothing can be seen, but the deposit is said to have been practically exhausted when work was abandoned.

*Walton Deposits.*—These deposits are situated near the contract between the Carboniferous and the Devonian, both to the east and west of Walton village, on the shore of Minas basin, at the mouth of Walton river.

The occurrences here are similar to the Tennycape ones, but none of the individual deposits discovered so far are as extensive. The manganese is found at the base of the Carboniferous limestone, which, however, appears to be less magnesian here than at Tennycape.

In numerous places along the contact between the limestone and the underlying Devonian shales and quartzites, pits have been dug on showings of manganese. Many of them go by the name of mines, but in the majority of cases the limited extent of the work done hardly warrants this designation.

The most extensive work has been done on the Stephens property and on the Churchill or Walton mine.

*Stephens Property.*—Mr. William Stephens has been carrying on work of a prospecting nature for some twenty years. This property is situated about three-quarters of a mile southwest of Walton village. The workings consist of a series of trenches and open-cuts, some of which are over 100 feet long by 40 to 50 feet wide, extending over a total length of some 1,200 feet. Two inclines, 60 and 70 feet long respectively, have been driven, and a shaft 40 feet deep is now being sunk. Small shipments of manganese ore are said to have been made from these places, but no large deposit has yet been encountered.

*Walton or Churchill Mine.*—This is a small, isolated outlier of limestone, lying a quarter of a mile north of the main development of Carboniferous rocks. Some comparatively large masses of pyrolusite and manganite have been mined from

this deposit by open cast work. The pit is now full of water, but the mine seems to have been pretty well exhausted of the visible ore at the time it was abandoned.

The main known occurrences of manganese ore in New Brunswick were next visited.

*Markhamville Deposits.*—These deposits occur near the contact of a small development of limestone with Pre-Cambrian rocks. The manganese ore is found in pockets and in reticulating veins, irregularly distributed in the limestone. The mine is situated at Markhamville, about nine miles in a straight line directly south of Sussex, in Kings county, New Brunswick. The workings consist of numerous open-cuts, trenches, a shaft and tunnels, scattered over an area of four or five acres. The limestone is probably slightly dolomitic, but effervesces very freely with cold, dilute hydrochloric acid.

Work was begun on the Markhamville deposits in the early sixties, and shipments of manganese ore were made, more or less regularly, during a period of twenty-eight years. Work was then abandoned after a rather careful prospection, which included the drilling of numerous diamond drill holes to depths of over 100 feet, in some cases. Presumably, the results of these explorations were not satisfactory. The ore was teamed to Sussex station, a distance of some fourteen miles by road, over very hilly country, and this was another of the great difficulties attending the working of this deposit. A rate of $2.50 per short ton for transporting the ore from the mine to the station was considered very low, and could be obtained only for comparatively large teaming contracts.

At one time, a well equipped plant for sorting, concentrating, and grading the ore was put up and used, but nothing of it now remains, even the buildings themselves having been removed.

The ore was high grade, although some second and third quality ores were also produced and shipped as blast furnace ore. However, owing to the irregularity of the deposits, and the difficulty of shipping, it is probable that the greater part of the profits was derived from the high grade ores, which brought high prices as compared with ores used in the manufacture of steel.

It is rather difficult to obtain accurate figures as to the total manganese ore mined at Markhamville, but as these mines were by far the most productive of the Canadian manganese deposits, it is safe to credit them with the greatest proportion of the total output of manganese ore from New Brunswick. A safe estimate would be about 20,000 short tons mined and marketed between the years 1865 and 1900.

*Jordan Mountain.*—The manganese deposits of Jordan mountain are situated five miles north of Sussex, in Kings county, New Brunswick. Although some limestone is said to be present in the immediate vicinity, the manganese ore is found in pockets and stringers in a conglomerate rock, made up largely of fragments of the underlying Pre-Cambrian beds. The distribution, however, is irregular, as in the case of the other known manganese ore deposits of the Maritime Provinces.

The Jordan Mountain deposits were discovered in 1882, and the workings, which occupy an area of a couple of acres, consist of an open-cut, about 100 feet long by 30 to 40 feet wide, and a shaft 40 feet deep, as well as shallow pits and trenches of an exploratory character.

From the available records of production, it would appear that the Jordan Mountain mine shipped between 400 and 500 tons of high grade ore between the years 1882 and 1900, although it is said that several thousand tons were extracted. There is at present at the mine a dump of comparatively good ore, containing in the vicinity of 250 tons, which could probably be shipped as blast furnace ore.

The nearest shipping point is Sussex station, on the Intercolonial railway, about six miles distant by a good road, which is down grade, except for a short stretch of a quarter of a mile or so, which is uphill.

*Shepody Mountain Deposit.*—Situated on the west side of Shepody mountain, in Albert county, at the base of a conglomerate of lower Carboniferous age. The ore consists of pyrolusite and psilomelane, distributed in irregular nodules and pockets. Work was begun at the mine in the early sixties, and carried on for some years. The workings consist of a main slope driven at an inclination of 45° in the side of a gully, in the bottom of which flows a small creek. This slope is said to be 250 feet long, and from it levels and cross-cuts have been driven. It is said that altogether over 1,800 lineal feet of driving have been done. These are now all caved in and cannot be entered.

No reliable data of the total quantity of manganese ore extracted from these workings are available, but it is said that some 1,600 tons were produced.

In a private report on this property by Mr. Francis D. Taylor, M.E., the probable cost of mining and preparing the ore for the market from this deposit is estimated at $15 a short ton, but the deposit is so irregular that it is difficult to arrive at anything approaching accuracy as to the cost of production in future operations.

*Dawson Settlement.*—There occurs at Dawson Settlement, five and a half miles northwest of Hillsborough, in Albert county, New Brunswick, a comparatively important deposit of wad, or bog manganese, which owes its origin to deposition by springs. This locality was visited in the fall of 1909, but only a short time was spent on the ground, and the following notes are mainly abstracts from previously published reports by Drs. Chalmers and Bailey, who both examined the locality in detail.

The deposit is situated on the west slope of the valley of Weldon creek, the opposite slope being occupied by Dawson Settlement. Over an area of eighteen or twenty acres, upon the removal of a thin coating of vegetable matter, usually not more than 2 inches in depth, a very fine black powdery deposit is uncovered, consisting essentially of manganese oxide. This deposit varies in depth from a few inches to more than 25 feet. From some seventy-three borings made a few years ago it was calculated that the deposit had an average depth of 6′-7¾″ over an area of seventeen acres. The weight of this material is about 1,900 pounds to the cubic yard. On this basis there would be available in the deposit about 175,000 tons of manganese ore.

It may be mentioned that the conditions here are ideal to establish an easy and cheap drainage system, and no difficulty would be encountered on the score of water. This is an important point, as in deposits of this nature the drainage is one of the main questions to be considered.

This deposit began to attract attention in 1887, and several attempts have been made to work it. At first, the ore was merely dried in kilns and shipped for the manufacture of ferro-manganese, but owing to its pulverulent state the product is said to have been very troublesome in the furnaces. In 1897, the Mineral Products Company erected a large plant for the drying of the ore and the manufacture of briquettes. These were shipped to Bridgeville, in Nova Scotia, to be used by the Preston Charcoal Iron Company in the manufacture of ferro-manganese. The enterprise was reported for a couple of years as being successful, when, for some unknown reason, work was completely abandoned, and the mine and briquetting plant have been idle since 1900.

It is said that the plant cost about $30,000, including the construction of a mile and a half of tramway connecting the mine with the Salisbury and Harvey railway.

There are at present several hundred tons of ore stored in the sheds near the briquetting plant, as well as several tons of the briquettes. Samples of each of these were secured and have been analysed by Mr. Connor, in the laboratory of the Mines Branch, with the following results:—

*Analyses of Manganese Ore from Dawson Settlement, New Brunswick.*

| | Crude Ore. | Briquettes. |
|---|---|---|
| Metallic manganese | 20·00 | 31·74 |
| Silica | 8·93 | 5·02 |
| Iron | 25·40 | 27·40 |
| Phosphorus | 0·17 | 0·16 |

The samples contain a comparatively large proportion of vegetable matter which was not determined.

## CONCLUSIONS.

As may be gathered from the above notes, the manganese deposits of the Maritime Provinces are irregular and pockety. This is compensated for, to a certain extent, by the fact that the ores are very pure and applicable to the uses which require the greatest purity. During the active period of operation of the mines in Nova Scotia and New Brunswick, from 1865 to 1890, very high prices prevailed for this class of ore, some shipments having brought $140 a ton. Although this price was exceptional, yet the average was very high. It is a significant fact that when prices for high grades ores fell to $40 a ton on the Boston and New York markets, work was practically abandoned in the Maritime Provinces, presumably owing to the inability of profitably mining the ores at these prices. In this class of deposits, where the ore supply is uncertain, where it is difficult to keep development and exploratory work well ahead of the actual mining, and where a great deal of dead work may be necessary to reach or mine the 'pockets,' the cost per ton of ore prepared for shipment is liable to vary between wide limits, but is not likely to be low under the most favourable conditions. The nature of such deposits does not permit of the installation of plants for economic mining and handling cheaply large quantities of material.

It would, therefore, be well for any one intending to resume work on any of the deposits of manganese of the Maritime Provinces to proceed cautiously, and to look carefully into the questions of markets, prices, probable cost of mining, etc. The principal market for such Canadian ores would, in all probability, be the United States, and in this connexion it is interesting to quote the following from the 'Mineral Resources of the United States for the year 1908.':—

'The prices of manganese ores used in the steel industry vary from $5 to $15 per long ton, according to the grade of the ore. They are governed by the following schedule of prices established by the Carnegie Steel Company:

Schedule of prices paid per ton of 2,240 pounds for domestic manganese ore delivered at Pittsburgh or Bessemer, Pa., and South Chicago, Ill.

Prices are based on ores containing not more than 8 per cent silica or 0·25 per cent phosphorus, and are subject to deductions as follows: For each 1 per cent in excess of 8 per cent silica there shall be deduction of 15 cents per ton; fractions in proportion.

For each 0·02 per cent, or fraction thereof, in excess of 0·25 per cent phosphorus, there shall be a deduction of 2 cents per unit of manganese per ton.

| Percentage of metallic manganese in ore. | Price per unit, in cents. | |
|---|---|---|
| | Manganese. | Iron. |
| Over 49 | 30 | 6 |
| 46 to 49 | 29 | 6 |
| 43 to 46 | 28 | 6 |
| 40 to 43 | 27 | 6 |

Ores containing less than 40 per cent manganese, or more than 12 per cent silica, or 0·27 per cent phosphorus are subject to acceptance or refusal at the buyer's option.

Settlements are based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken being deducted from the weight.

The manganese ores for oxidizing and colouring purposes are valued according to the quantity of manganese peroxide present; their consistency, etc., and prices range up to $25 per ton for the better grades of ore.'

In late years the immense deposits of manganese ore discovered in India, Russia, and Brazil have been supplying the greater part of the markets of the world, and some idea of the importance of this industry in the three countries mentioned may be gathered from the fact that in 1907 India produced 912,761 metric tons, valued at £911,943; Brazil, 236,778 metric tons, valued at £500,611; and in 1906 Russia produced 1,018,961 tons, valued at £423,964.

The following analyses of manganese ores from some of the Canadian deposits visited in 1909 have been taken from various sources:—

| —— | Metallic Manganese. | Iron. | Analyst. |
|---|---|---|---|
| Tennycape mines | 60·05 | ........... | Dr. How. |
| " | 55·63 | ........... | " |
| Markhamville | 60·00 | 0·55 | |
| " | 62·40 | 0·75 | |
| Jordan mountain | 52·88 | 0·83 | Otto Werth. |
| " | 57·37 | ........... | Pa. Steel Co. |
| Shepody mountain | 51·96 | ........... | Ledoux and Ricketts. |
| " | 50·67 | ........... | J. J. Donald. |

# IRON ORES, AND METALLURGICAL LIMESTONES OF NOVA SCOTIA—THIRD SEASON.

*Dr. J. E. Woodman.*

Acting under your instructions, several iron and limestone districts were examined, which it was not possible to visit during the season of 1908. Some time has also been occupied with office work in completion of the second volume of the report.

## IRON ORES.

Sporadic occurrences in Halifax county were studied, none of which gave any promise. In northern Antigonish and eastern Pictou counties is a district, north of the Intercolonial railway and south of the Arisaig field, that may merit study. The ore is a bedded hematite, appearing to be of good grade in the specimens seen. It was impossible to secure a guide, and without one search for the ledges would have been futile; hence nothing is known at first hand as to the amount and distribution of the ore.

*Pictou County.*—The only extensive region of apparent importance not included in the previous year's work was Pictou county. The ores there may be divided roughly into four groups—contact pockets at the base of the lower Carboniferous limestone (Windsor series), veins of siderite in the Carboniferous, unimportant ankerite veins with specular hematite in the Devonian, and interbedded hematites, chiefly in the Silurian. The second may be dismissed with the statement that nowhere in Pictou county are ankerite veins known to be of commercial importance.

The contact pockets have been developed by a chain of mines east of the Intercolonial railway and along the branch line of the Nova Scotia Steel and Coal Company road, and chiefly in the vicinity of Springville and Bridgeville. All the known deposits have been worked out to the limit of profitable mining by the Nova Scotia Steel and Coal Company and abandoned in favour of their Newfoundland bedded hematites. But it is quite possible that other pockets may be found upon further exploration, and they should prove to be as high grade as those formerly worked.

The contact of the lowland rocks of the Windsor series with those of Ordovician and Silurian age forming the highlands is sinuous, the curves as outcropping on the present land surface being now large, now small, and with little if any rhythm of interval. For this reason prospecting for pockets that do not outcrop, or from which 'float' does not extend, is attended with uncertainty. In those portions of the contact that reach back as embayments into the oldland, the base of the Windsor series has often been replaced by a high grade limonite, locally botryoidal or stalactitic. Some occurrences or parts of them are high in manganese, some almost free. The iron replacement is possible only where a soluble rock, such as limestone, forms the basal member of the series. In form the pocket is a warped disc, concave upward and outward towards the lowland. The grade of the ore is shown by the following series of analyses from the J. W. Cameron mine at Bridgeville. No. 450 is a general sample of limonite on the dump, excluding the high grade, hard, black ore and the manganic ore; 451 is hard botryoidal limonite, and 452 selected manganic ore from 200 pounds collected from different parts of the dump.

| — | Fe. | Insoluble. | Mn. | P. | S. | Loss on Ignition. |
|---|---|---|---|---|---|---|
| 450 | 50·79 | 17·10 | 0·54 | 0·074 | 0·028 | 8·67 |
| 451 | 56·02 | 9·02 | 0·46 | 0·032 | 0·023 | 10·15 |
| 452 | 27·92 | 2·31 | 31·80 | 0·062 | 0·002 | 11·02 |

Pockets of this class cannot be depended upon for permanent supply under present industrial conditions, but would furnish good ore for mixing with bedded hematites if the latter should ever prove to be attractive enough in quantity and quality to justify re-establishing a smelting industry in Pictou county.

Much has been written about the bedded hematites of the Silurian in the early years of the study of Nova Scotian geology. It must be admitted that much of the optimism then exhibited must have been due to non-appreciation of the points wherein iron differs from other ores in its economics. That there is a large amount of hematite interstratified with the sediments in the uplands is certain. But, after many years of intermittent search, it has not proved to be so abundant or the continuity of its beds so great as was stated with positiveness by those who examined the region forty or fifty years ago. The country is much broken by faults, so that long stretches of unbroken ore are not expected. Much of the hematite is exceedingly lean and siliceous, and would not repay exploitation under present market conditions. Thus the Webster ore, from South McLellan mountain, runs in picked specimens from 23·80 to 41·42 Fe, the latter being the only analysis giving over 30 per cent. The Wentworth 'eighteen-foot bed' on Sutherland river gave 31·41 in a cross-section sample. The best seen was on the Sutherland-Meiklefield property, west of French river and east of the St. Mary road, where an oölitic red hematite occupies one or more thin beds. But this gave only from 41·58 to 43·61 Fe.

To sum up, there have been discovered as yet no bedded ores in this county that could be worked with profit at present, but there is every possibility of the presence of such deposits.

Much has been made by some early students of the region of the carbonate ores which occur in irregular vein-like deposits at several points. Aside, however, from the fact that spathic ores are now of little value, those of Pictou county are apparently very impure. The occurrences seen were of so low grade that no samples were taken.

### LIMESTONES.

The work on limestones consisted in visiting isolated localities not seen in 1908, chiefly inland along the line of the Intercolonial railway. The rocks containing these belong to the Windsor series. In western Antigonish and eastern Pictou counties large areas are underlain by soluble rocks containing either gypsum or limestone. But the strata of the latter are thin and variable, and even though their outcrops are often close to the railway they appear to have no economic importance.

On the south and west flanks of the highlands of Pictou county the rocks that carry the limonite pockets described above also contain workable beds of dense limestone, some of which were extensively quarried at one time. Thus, east and north of Springville is a persistent limestone horizon which can be traced without a break for more than two miles. At the south end is the quarry from which formerly the Nova Scotia Steel and Coal Company procured the lime for its works at Ferrona. Samples of this bed were taken at various points within the two miles, none of which

gave less than 95·80 $CaCO_3$, or more than 2·66 insoluble matter. The working bed has a variable thickness, averaging at least 15 feet, and dips west at a low angle. In places it could not be quarried with profit, owing to the low topography.

West of the Intercolonial railway, especially back of Hopewell, are a number of thin but good limestones, all of which would be handicapped by a haulage of nearly or quite two miles to rail. At Dunbar's quarries, near Lorne, is the largest single deposit seen, and easily accessible to the railway; but averaging not less than 5·13 insoluble matter.

On the south shore of the Province, west of Halifax, are several isolated deposits of Carboniferous limestone, at least one of which is very promising as regards quality and shipping facilities. This constitutes the Lordly and adjoining properties at East river. The rock body is of considerable extent, and lies directly at the water's edge, but the landing is somewhat exposed. The insoluble matter of the samples taken runs from 0·88 to 3·72, with an average of 1·65 per cent.

# MAGNETIC SURVEY OF SOME MINING LOCATIONS AT TIMAGAMI, ONT.

*Einar Lindeman, M.E.*

## I

In May, 1909, the writer received instructions to make a magnetic survey of locations W. D. 341, E. T. W. 340, W. D. 324, and W. D. 351, which are situated north of the northeast arm of Lake Timagami, and from half a mile to one mile from Timagami station on the Timiskaming and Northern Ontario railway. The field work was commenced on May 27, and occupied about seven weeks, all the necessary help for the survey being provided by the owners of the claims. A base-line was cut out and chained, starting from the line between lots 339 and 340, 152 feet south of the northwest corner post of lot 340. The length of the base was 6,400 feet and its bearing N 65° E, roughly following the general strike of the formation. At right angles to this line and at intervals of every 50 feet cross lines were run. Magnetic observations of both the vertical and horizontal intensity were made at a distance of every 25 feet along these lines with the Thalen-Tiberg magnetometer.

By means of these observations it was possible to trace the iron formation through all the locations, even through intervening swamps, where no outcrops occur.

It was also possible to locate the richer and more continuous portions of the iron-bearing rocks, which are often separated from each other by leaner material, chiefly jasper and schists.

Maps showing the details of these magnetic observations are now being prepared and the results obtained will be incorporated on a separate map of the area.

### CHARACTER OF THE IRON-BEARING FORMATION.

The iron formation of the locations is a siliceous magnetite, interbanded with variously coloured jasper, lying in and surrounded by sericite and chlorite schist of Keewatin age. The general strike of the formation is about N 65° E, with a steep dip towards the north.

In order to ascertain the iron content, ten samples were taken in different parts of the field, where strong magnetic attraction indicated the magnetite to be more concentrated. In each place, crossing the formation at right angles, two handfuls of material were taken for every foot, and made up into one sample; the width of the outcrops varying from 18 to 100 feet. The samples might, therefore, give a fair average of the iron content of the places they represent. The following analyses were made by Mr. H. Leverin of the Mines Branch:—

| Sample. | Iron. | Insoluble Matter. | Sulphur. | Phosphorus. | Notes. |
|---|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. | |
| I........ | 21·3 | 68·7 | .......... | .......... | Width of outcrop 40 feet. |
| II........ | 24·5 | 64·2 | .......... | .......... | " 30 " |
| III........ | 22·6 | 66·2 | .......... | .......... | " 35 " |
| IV........ | 27·2 | 59·8 | .......... | .......... | " 100 " |
| V........ | 18·6 | 72·4 | .......... | .......... | " 25 " |
| VI........ | 21·7 | 66·9 | .......... | .......... | " 45 " |
| VII........ | 24·2 | 63·4 | .......... | .......... | " 32 " |
| VIII........ | 23·2 | 66·0 | .......... | .......... | " 18 " |
| IX........ | 23·6 | 63·3 | .......... | .......... | " 32 " |
| X........ | 25·9 | 59·3 | .......... | .......... | " 36 " 'T. B. Mine.' |
| XI........ | 38·8 | 41·3 | 0·160 | 0·096 | Specimen of magnetite. |

Thus, the assays of the ten samples give returns of metallic iron, ranging from 18·6 to 27·2 per cent and showing an average of 23·3 per cent.

The determinations of insoluble matter give an average of 65·02 per cent when the sulphur and phosphorus content, determined in two samples, ranges from 0·016 to 0·091 per cent of the former, and from 0·026 to 0·064 per cent of the latter. Sample XI is a piece of magnetite from one of the richer iron bands, in which no siliceous matter could be seen by the naked eye. The high percentage of insoluble matter shows, however, the extremely intimate association of the magnetite and silica.

In addition to the above-mentioned work, the greater part of the autumn was spent in the making of a special investigation of the iron ore deposits of the Bristol mine, situated in Pontiac county, north of the Ottawa river, Que. Particulars of this examination, including a magnetometric survey map and topographic map of the mine area; together with the results of Mr. Mackenzie's concentration tests of iron ores taken from the Bristol mine deposits—will, I understand, be published in bulletin form at an early date.

# ON THE COPPER MINING INDUSTRY IN QUEBEC.

*Alfred W. G. Wilson, Ph. D.*

The summer season of 1909 was spent by the writer in studying the present status of the copper mining industry in the Province of Quebec. The occurrence of ores of copper was known in the Eastern Townships of Quebec as early as the year 1841, and the report of the Geological Survey for 1866 gives a list of 525 localities in which the minerals of copper had been found; yet at the present time there is but one shipping mine in active operation. During the ten years preceding 1866, the high price of copper, and the rich character of the ores found in a few localities, stimulated prospecting and mining. The subsequent decline in the price of copper from a maximum of 29·3 cents per pound in 1907, to about 9 cents in 1886, coupled with the fact that many of the deposits discovered were apparently soon exhausted, was a severe check to the industry—a check from which it has never fully recovered.

During the decade preceding 1885, several properties were opened, and even though the market price of copper was low, they were worked at a profit, because operated on a better economic basis. One of these properties has been in continuous operation ever since—the Eustis mine; while another—the Capelton mines—was only closed down about two years ago. In both instances profitable working of the mines seems to have been directly associated with the utilization of the sulphur content of the ores; better transportation facilities have also been an important factor in obtaining this result.

During the course of this investigation the writer has visited every locality about which any information could be obtained either from old reports or from personal interviews. In all about two hundred localities were visited. In some places no trace of the original discoveries could be found; in others the present occupant was not even aware that any copper minerals had ever been found in the locality, while in many instances the showing was such that the writer does not consider that any exploration work was ever justified. In those places where mining operations had been carried on, the old workings were usually full of water, and caved; while the old dumps were often overgrown with vegetation. Adjacent rock outcrops are usually small, and are more or less completely obscured by soil and vegetation. In the few instances where it has been possible to compare early reports with the actual condition, the writer has been compelled to recognize that the early reports must be largely discounted. In localities where access cannot be had to the old workings, and where surface indications are very meagre, the writer would hesitate to accept any statements with regard to the property in question in the absence of recent and adequate exploration.

The deposits of rich ores—the outcrops of which were located in the early days—were usually in the nature of pockets. In a few localities these pockets were of considerable size, but in the majority of cases they were small. These ore pockets were, however, very widespread throughout the copper-bearing rocks of the Eastern Townships, and there is every reason to believe that others may exist in the same district. The recently discovered McDonald mine, lot 22, range II, Weedon, is one of these; it is now in the course of development, and its size has yet to be determined.

There are several localities in the vicinity of old workings where further exploration by modern methods would be justified. Two of these can be specifically referred to at the present time:—

*Harvey Hill.*—At the old Harvey Hill mine one of the ore bodies was known as the 'interstratified bed.' This was a band of schists through which pyrite and chalcopyrite were disseminated—the band varied from 4 to about 7 feet in thickness, and yielded a rich concentrating ore. It is very probable not only that this impregnated zone may extend beyond the old workings, but that other quartz veins carrying the rich bornite ores which were so characteristic of Harvey Hill in the early days, may be discovered. The writer is of opinion that, the early miners removed all the valuable ore they could find from the Harvey Hill mines, and that if the old mines were re-opened, little ore would be found at the old faces, though low grade ores may have been left behind. This belief, however, does not militate against the possibility that the impregnated band extends laterally beyond the old workings and also below them. It must be noted that at the present time the old workings are all full of water and inaccessible.[1]

*Sherbrooke District.*—The other locality to which the writer would specifically refer at the present time, includes the district in the vicinity of the Eustis and Capel mines and extends on either side of it for at least two miles, if not further. The character and size of the ore bodies already located in this district, coupled with the fact that very little systematic exploration has been carried out, are such that, detailed scientific exploration is both justifiable and desirable. In fact, exploration of this character is also justified at a number of localities in the vicinity of several of the old mines which lie between this district and the Moulton Hill mine, northeast of Sherbrooke.

### PROPERTIES IN OPERATION.

*Eustis Mine.*—At the present time the only copper mine in active operation is the Eustis mine, situated in the township of Ascot, about nine miles from Sherbrooke. The ore is pyrite, containing small amounts of chalcopyrite. The shipping ore contains from 40 to 45 per cent of sulphur, and usually less than 2 per cent of copper, with very small values in gold. The annual shipments, according to the report of the Quebec Department of Mines, are in the neighbourhood of 30,000 tons. The present management at the Eustis mine hope to largely increase this output in the near future. The mine is operated by electric power, generated on the Coaticook river, and the small water supply at times greatly handicaps operations at the mine.

A small portion of the Eustis ore is utilized at the chemical works in Capelton. The greater part of the ore is shipped out of Canada to various chemical works in the United States. The residues—after the extraction of the sulphur—are for the most part shipped to the smelter at Norfolk, Virginia, belonging to the principal owners of the Eustis company.

During the summer of 1909 prospecting and development work was carried on at a number of properties in the Eastern Townships.

*Memphremagog Mine.*—At the Memphremagog mine, about two miles from Knowlton landing, on Lake Memphremagog, a new shaft was sunk about 150 feet north of the old shaft. At the time the mine was visited (July) this shaft had passed through the ore, and was being sunk in the country rock near the contact between the diabase with which this ore is associated and the schists. The old shaft has also been unwatered and was being deepened. The ore is pyrrhotite, containing a very small amount of chalcopyrite, which usually appears as thin films along fracture planes. Near the south shaft the ore body has an extreme width of about 20 feet,

1. A detailed report on this property, dated May, 1899, by Mr. John Daw, jr., is on file at the Mines Branch office. Extracts from this report showing the underground conditions will appear in the report on the copper ores of Canada.

and a length, probably, of about 200 feet; the average width being about 12 feet. In the opinion of the writer, the total amount of ore, as shown by the workings at the time the mine was visited, will not be more than 20,000 tons; the copper content is very low, probably less than 2 per cent. Disseminated pyrite had been found in a number of pits and trenches to the north along the line of contact between the diabase and the schists, but no new ore bodies of commercial value had been discovered at the date when the mine was visited.

*Hepburn Mine.*—The Eustis Mining Company has installed a small hoist at the old Hepburn mine, lot 7, range II, Ascot, and is engaged in re-opening the mine. At the present time an ore band about 4 feet in width, carrying pyrite and chalcopyrite, has been exposed in the bottom of the old shaft.

*Suffield Mine.*—At the Suffield mine, development work, which has been in progress for three years, was still going forward. Here a very large volume of low-grade siliceous ore—pyrite and chalcopyrite—has been developed. This mine contains the largest amount of 'developed' ore in the Eastern Townships; but no shipments have been made in recent years. The ore is rich in silica and alumina, the sulphides being finely disseminated through a schistose rock consisting of quartz and sericite mica. For smelting purposes it will prove very refractory. The ore is very low grade, and while concentration is possible, the losses will be large on account of the fine state of division of much of the sulphides. This ore also contains small values in gold somewhat irregularly distributed; a small amount of silver is also found in many assays. Its value as a commercial ore under present conditions has yet to be proven.

On the adjacent property belonging to the same owner, the King mine, a considerable amount of ore has also been partially developed, but the mine is now full of water. The ore body shows almost pure sulphides; no data are available as to its size. The ore is richer in copper and carries more gold and silver than the ore of the Suffield. The owner of both properties is Mr. A. O. Norton, of Coaticook, Que.

*McDonald Mine.*—About seven miles by road, northeast of Weedon station, on lot 22, range II, Weedon, the East Canada Smelting Company is investigating a property known as the McDonald mine. In this locality a prospecting pit has been put down on a deposit of almost pure sulphides—pyrite and chalcopyrite: portions of the ore will assay high in copper. The development work has not proceeded far enough to disclose the size of the ore body, but the prospect is a promising one.

*Ditchfield Mine.*—A few hundred yards from Trudel siding on the Canadian Pacific railway, on lot 9, range VI, Ditchfield, almost six miles east of Lake Megantic, a small plant has been installed, and a shaft is being put down. The country rock is a mica-quartz schist. A small quantity of pyrite is present disseminated through a narrow band of the schists, but copper sulphides are practically absent. The writer could see nothing to justify any further expenditure in this locality.

*Ducket Mine.*—East of the Chaudiere river, in the Parish of St. Joseph, about one mile south of St. Joseph village, exploration work is being carried on. A shaft is being sunk on a small vein carrying irregular masses of chalcocite. The chalcocite masses are roughly lens-shaped, rarely over 2 inches in thickness. In sinking the shaft they have been found to pinch out and come in again, and none of any large size have been disclosed.

*Turgeon Mine.*—On the property adjoining the Ducket mine, on the south side of Galway creek, another pit is being sunk in a somewhat similar deposit. The country rock of the locality is a dark green serpentine, irregularly fractured, many of the fractures showing copper stains. No ore of consequence has been found, and the writer would hesitate to recommend further exploration on either property.

*Actonvale Smelter.*—At the present time a small smelter of about 40 tons capacity is being erected at the old Acton mine, lot 32, range III, Acton. The old dumps on

this property must contain approximately 50,000 tons of waste. So far as the writer can learn the dumps have never been sampled. They undoubtedly contain some copper, probably less than 1 per cent. A concentrating plant is to be erected later for treating the ore on these rock dumps. The rock associated with the copper ore is a dolomitic limestone, containing approximately 87 per cent calcium carbonate, and 10 per cent magnesium carbonate, with about 1·6 per cent insoluble matter, and the balance, oxides of iron and aluminium. Copper ore is present as chalcopyrite and bornite, the ore, as may be expected, being very irregularly distributed in the dumps. The plant is being erected by Pierre Tetreault, 407 Power Building, Craig street west, Montreal.

*Types of Ores.*—The types of ore which occur in the Eastern Townships may be classified on the basis of their composition as follows:—

Pyrite and chalcopyrite, nearly pure sulphides, the copper content varying from a mere trace to more than 12 per cent, as at Eustis, Capelton, and elsewhere.

Pyrite and chalcopyrite disseminated through a highly siliceous gangue, as at the Suffield mine.

Chalcopyrite and bornite disseminated through a calcareo-magnesian limestone, as at Actonvale and vicinity.

Bornite in a siliceous gangue, usually quartz, as at Harvey Hill.

Pyrrhotite containing a small amount of chalcopyrite, as at Memphremagog mine.

Chalcopyrite and pyrite with quartz, and associated with a basic igneous rock, as at the old mines near St. Flavien.

Chalcocite, in small amount, associated with quartz, and more rarely with serpentine, occurring in several localities, but relatively unimportant.

*Developed Ore.*—The Suffield mine is the only property in the district, except the Eustis, so developed that a steady output could be assured. The quantity of ore immediately available for stoping has not been estimated. The size and shape of the ore bodies is unknown, and the developed portions have not been systematically sampled since the development. The ore is rich in silica and alumina, is low grade, and will prove very difficult either to concentrate or smelt.

At the Eustis mine, although development work has proceeded far enough in advance of stoping to show that there is a very large body of ore in reserve, it would not be possible to make an accurate estimate of the reserves at the present time.

At several of the mines old dumps exist that contain large quantities of valuable ore. The old dumps of the Eustis mine are said to contain about 75,000 tons of waste. The richer portions of these dumps are now being put through the mill, and it is probable that over 25,000 tons of shipping ore will be recovered.

At the Albert and Capel mines there are large dumps. Much of this waste has already been treated by crushing and jigging. Portions of the dumps still contain good concentrating ore. On the same property, at the Crown mine dumps, there is also a small quantity of concentrating ore.

The dumps at the Ascot mine contain a small quantity of rich ore.

At Actonvale, large dumps also occur, containing a small quantity of rich ore.

These dumps have not been sampled or measured. The material composing them varies in size from fines to blocks containing 3 or 4 cubic feet. Many of them have been exposed to the atmosphere for many years, and much of the copper content may have been leached away. Several months would be required to sample them carefully, the expense would be very considerable, and it is not within the province of the Mines Branch to value the property of individuals.

STATEMENT OF GENERAL CONCLUSIONS.

Copper mining in Quebec has had a varied history. With the exception of two mines, at Eustis and at Capelton, it cannot be said to have ever been very successful. It is true that in a number of localities, notably at Harvey Hill and at Actonvale, pockets of very rich ores were found in the early days—but none of these deposits has ever produced a large tonnage, and most of them were soon exhausted. While it might be stated that lack of ore has been the chief cause for this lack of success, as a matter of fact it has never been demonstrated that this is the cause. The one surprising feature in connexion even with those mines that have been successfully operated is the extraordinarily small amount of scientific exploration that has been carried on. There has been almost no lateral exploration and no boring of consequence. Ore-bodies were found, the ore was mined out as it occurred, but there was almost no development work ahead of the mining. Periods of very reduced output followed periods of large output. At the present time in the Eustis mine development in the shaft is about 200 feet ahead of the lowest level from which ore is being mined, and four new drifts have been started from two new levels. Again at the Suffield mine, a comparatively large tonnage of low grade ore has been blocked out on four sides. This ore reserve has not been systematically sampled, and has not been surveyed, but it is undoubtedly the largest amount of developed ore available in the district. The writer is inclined to think that it will be found very difficult to recover the values in this ore, partly because of its siliceous nature, and partly because of the finely disseminated character of the sulphides, which will make it difficult to concentrate. So far as can be learned these are the only occasions in which development work to any extent has preceded mining. In the Eustis mine, the ore showings are probably the best in its history. In the Suffield, the value of the ore and a method of extracting these values at a profit have yet to be determined.

Apart from the natural depression which results from the low price of copper, the writer is strongly of the opinion that the present backward condition of the industry in Quebec is due to several other factors. One of the most important contributary factors is the attitude assumed by the majority of the owners of undeveloped and unexplored prospects. Until these prospects are properly investigated nothing can be known as to their value. In the greater number of cases the owners are not financially able to undertake the work themselves, nor have they the requisite knowledge. This very lack of knowledge, coupled with the absurd popular notions as to the value of a mineral prospect, which the owner usually assumes is already a mine, causes them to place an extraordinary valuation on undeveloped properties. Most of the owners not only will not assume any of the risks attendant on initial exploration, but ask such prices for their properties—in some cases not being willing even to have them adequately tested first—that capitalists experienced in copper mining have no choice but to leave the district. Could owners be made to understand that a copper mine does not consist of a few small showings of copper ores in the bottom of a small pit, that a mine has to be developed from a prospect by hard and continuous labour like any other industry, that in the majority of cases the assays which they have received from some commercial chemist, of specimens not independently collected, are no indication whatever of the actual content of their property—then, and then only, when owner will meet capitalist on the common ground of mutual interest, will it be possible for the interests of both to be so adjusted that the prospects themselves may be properly investigated.

Lack of a convenient market has also retarded the industry. The erection of a custom smelter at some central point in the district has been advocated as a solution of this difficulty. It is doubtless true that a custom smelter would enable small owners to obtain immediate returns from their ores. But from the standpoint of the smelter owner it is difficult to understand how he could expect to operate his

plant at a profit unless an adequate supply of suitable ores were assured. On various occasions small smelters have been erected at different localities to treat the ores of individual mines. Undoubtedly some of them were operated at a profit, but many were not, and in all cases the smelting costs were high and the plants could only be operated when the market price of copper was high. The high costs were in part due to the fact that usually the ore was all of the same type, being derived from one mine or group of mines, and when smelted alone it proved refractory. Had provision been made to obtain different types of ores from several localities so that a proper smelting mixture could have been obtained, costs would undoubtedly have been lower. Now, while a custom smelter centrally located could undoubtedly obtain some suitable ores from the district, at the present time no assurance whatever can be given that the supply will be constant, even for a limited period of time, nor can any accurate estimate be made of the quantity available.

A company proposing to erect a custom smelter should first assure itself of an adequate supply of suitable ores, and it would seem reasonable to this end that they should control several properties which would produce different classes of ore. The properties themselves should actually be opened up that the character of the ore may be known and a reasonable quantity be actually in sight, that is, developed on four sides. To a well-trained engineer or business man it may appear strange that it should even be necessary to make this statement, but the past history of mining and smelting ventures in the district repeatedly shows that the search for a commercial quantity of ore was the last step taken in the organization of such enterprises.

At the present time, in the absence of a suitable market, only the richer ores can be shipped to distant purchasers at a profit, and transportation charges consume a large portion of the values in the ore. The small owner, with little capital, cannot afford to do much development in advance of sales, and the profits are usually so small that it is hardly worth while investigating his property at all. On the other hand, the lack of an assured supply of ore renders the erection of a smelter a hazardous venture. These difficulties could be overcome by co-operation between the owners and capitalists, and the interests of both would be served.

There are a number of prospects known where there is a possibility of finding ore of value. These should be thoroughly investigated. When an adequate supply of ore is assured, then, and then only, will it be desirable to equip the mines with plants of suitable capacity. When the nature of the ores is known and an output of reasonable quantity is assured, it will be possible to devise a method of treatment and to design and erect a suitable plant at some convenient central point.

### A POSSIBLE HOME MARKET FOR QUEBEC PYRITE ORES.

It is only within very recent years that many of our Canadian commercial organizations have recognized a principle that is almost fundamental to successful operation—that the profits which accrue in any enterprise are greatest when the same organization markets finished products—the source of raw material as well as the manufacture being controlled by the same organization. Where raw material or partially manufactured products are handed over to other firms for final treatment a very considerable portion of the total profits on the various operations is lost to the producer of the raw material, and incidentally the cost of preparing manufactured articles for the market is greatly increased. In practice it is not always possible to completely carry out this principle, but there are in Canada many industries where the recognition of the principle and its application within reasonable limits would result in many benefits not only to the properties most immediately concerned, but also to the country as a whole.

Where the diverse nature of manufactured products requires raw materials of different kinds derived from many different sources it is manifestly difficult, though not impossible, for any one industrial organization to control both the sources of

supply and the processes of manufacture. In such cases it is obvious, however, that co-operation between two or more great industrial organizations would undoubtedly lead to economies in production costs. This is especially true when the waste products of one industry are the raw material of another, and this happens to be the relation which exists between the copper and sulphur mining industry and the sulphite pulp industry.

During the summer of 1909, when driving through various sections of the Province of Quebec, covering a total distance in excess of 2,000 miles, the writer was particularly impressed with the very large amount of spruce pulpwood that was being prepared for shipment to the United States. The average price paid for this wood was about $7 per cord for wood free from bark delivered at the railway.

So great is the demand and so energetically have the farmers and others responded to this demand that large areas have been completely denuded of valuable trees. In a few localities some local residents have gone so far as to cut large spruce trees which were growing on the road allowance—these trees were actually the property of the municipality. In addition, much pulpwood has been cut on Crown lands. Statistics showing the total quantity of pulpwood exported from the Province of Quebec during the year 1909 are not available; it will probably total nearly 1,000,000 cords.

The following tables, compiled from the Trade and Navigation Reports, issued by the Department of Customs, will serve to indicate the volume of trade in pulpwood and wood pulp in and out of Canada. The data given are for the fiscal year which ends on March 31. No data are available showing the total home consumption of pulpwood and wood pulp.

### Statement showing the Pulpwood Exported from Canada, 1907-8-9.

| — | 1907. | 1908. | 1909. |
|---|---|---|---|
| Quantity in... cords. | 619,648 | 902,311 | 794,986 |
| Value in... dollars. | 2,720,500 00 | 4,656,721 00 | 4,356,391 00 |
| Value per cord... " | 4 39 | 5 16 | 5 48 |

### Statement showing the Wood Pulp Exported from Canada, 1907-8-9.

| — | 1907. | | 1908. | | | 1909. | | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity in cwt. | Value. | Value per ton. | Quantity in cwt. | Value. | Value per ton. |
| | | $ | | $ | $ cts. | | $ | $ cts. |
| Wood pulp chemically prepared ... | ........ | 4,027,759 | 783,224 | 1,385,754 | 35 40 | 826,585 | 1,603,006 | 38 40 |
| Wood pulp mechanically prepared ... | .......... | ........ | 4,027,939 | 2,652,098 | 13 16 | 4,162,509 | 2,703,923 | 13 00 |

### Statement showing the Value of Wood Pulp Imported into Canada, 1907-8-9.

| Source. | 1907. | 1908. | 1909. |
|---|---|---|---|
| | $ | $ | $ |
| United States ... | 33,435 | 56,416 | 31,173 |
| Other countries... | 2,525 | 2,141 | 4,079 |
| Total... | 35,960 | 58,557 | 35,252 |

It has recently been announced that it is the intention of the Quebec government to prohibit the export of the pulpwood from the Crown lands of the Provinces. This action is to be taken partly for the purpose of conserving the pulpwood resources and partly with the object of stimulating home manufacture. While it is very probable that the first effect of this legislation will be to greatly reduce the amount of wood exported, it seems altogether probable that eventually the home manufacturing industry will be greatly increased. No data are at hand to show the present Canadian home consumption of pulpwood and wood pulp. The tables on a previous page show that the amount of imported wood is small—though they do not indicate whether this pulp is chemically or mechanically prepared.

If anticipations are realized and a large home manufacture of wood pulp is maintained, at least a portion of this wood pulp will be chemically prepared. One of the most important of the chemically made pulps is that known as sulphite pulp. In the preparation of sulphite pulp by the methods at present in vogue in Canada about one ton of raw sulphur, costing about $22 per ton, is required for every 10 tons of sulphite pulp. It is possible, however, to prepare the sulphur dioxide required by this process from pyrite, or other ores containing a mixture of pyrite and chalcopyrite. In utilizing pyrite ores for this purpose some practical difficulties have been encountered because sulphur trioxide is usually formed at the same time as the dioxide. In chemical works the presence of the trioxide is more desirable than otherwise, but in pulp manufacture it is injurious. Commercial methods for preparing the pure dioxide from pyrite are available. In the United States there are two large mills in operation where ores of this character are being utilized for this purpose. Thus, there seems to be no reason, so far as the actual successful operation of a process is concerned, why Quebec sulphide ores could not be used in Quebec as a source of supply of sulphur for the preparation of sulphur dioxide to be used in the manufacture of sulphite pulp. There are also several plants in successful operation where sulphur dioxide is extracted from smelter fumes for the purpose of making sulphuric acid. If, in the future, conditions should warrant the erection of a smelter in the Province of Quebec, its location in a locality where the sulphur dioxide fumes could be utilized for other purposes would be in the interests of economical operation.

While it is not possible to give a detailed statement of actual operating costs, the following data, which are only tentatively submitted here, will serve to illustrate the possibilities of economical operation in this direction.

One cord of spruce pulpwood free from bark will produce about 2,350 pounds of mechanical wood pulp, worth, on the New York market, about $14 per ton. The same cord of pulpwood will produce about 100 pounds of sulphite pulp worth approximately $40 per ton. Hence, one cord of spruce pulp, which was worth $7 per cord on the railway in Quebec in the summer of 1909, when manufactured into mechanical pulp was worth $16.45; if manufactured into sulphite pulp, it would have been worth $22. At the present time there are no methods in use for conserving the large fraction of the pulpwood which is lost in the waste liquors from the sulphite pulp process; doubtless they will be discovered in the future.

To convert a cord of pulpwood into sulphite pulp about 100 pounds of sulphur are required, worth approximately $1.10. Assuming an ore containing 40 per cent recoverable sulphur, 0·125 tons of ore would furnish the equivalent amount of sulphur. At a market price of 10 cents per unit, the value of the sulphur content of this weight of ore would be about 53 cents[1], assuming that no sulphur trioxide is formed. In practice enough additional ore must be roasted to balance the sulphur trioxide losses. The cost of this additional quantity of ore and the cost of removing the trioxide must be taken into consideration. Exact data as to these costs are not available, but they will be relatively small.

[1] Note that if the ore contains 40 per cent recoverable sulphur, its sulphur assay will probably be between 42 per cent and 43 per cent, and payment is usually made on the assay sulphur, not on the recoverable sulphur.

Such additional costs as may accrue because of the more bulky nature of the ore, and because of the additional handling required, can also be paid out of the balance, in favour of using pyrite. As all this work can be done very cheaply and economically by mechanical means, there will still be left a very large margin of profit in favour of pyrite ore as against raw sulphur. Moreover, the cinder residues, after roasting, can all be utilized. If there is a copper content it can be recovered by leaching. The iron content can be used directly, or after briquetting, in a variety of ways. Ferrosilicon can be produced in an electric furnace—(the market for this product is, however, overstocked at the present time). As a source of iron ore these residues will always be in demand. Hence their value should be more than sufficient to pay the additional charges involved in the handling of pyrite ore and its residues when extracting the sulphur content by a roasting process. If the sulphur content of the ores can be utilized nearer their point of production, there will also be, for the miner, a saving in transportation costs.

If subsequent investigations should warrant the establishment of a smelting industry primarily to recover the copper and precious metals in the ores, a very considerable portion of the waste sulphur dioxide gases could be economically utilized in a sulphite pulp mill. The relative capacities of the two plants, and the character of the ores will determine whether the whole of the sulphur could be thus economically conserved.

A sulphite pulp mill of 100 tons per day capacity could only utilize the sulphur fumes from about 25 tons of ore containing 40 per cent recoverable sulphur, or about 50 tons of ore containing 20 per cent recoverable sulphur. A smelter of 50 tons daily capacity is, of course, a small affair. A large smelting industry would probably have to provide other means for utilizing a portion of the otherwise waste sulphur. In some localities, notably Tennessee, this is done by manufacturing sulphuric acid, the acid in turn being utilized for the manufacture of fertilizers. At the present time it is improbable that the Canadian market can absorb an increased output of acid. It is also an expensive product to transport and it is very doubtful if an additional output from Canadian centres could be marketed at a profit. It is probable, however, that in the near future the farming population of the Eastern Townships of Quebec, as a whole, will begin to appreciate the value of modern scientific methods of farming. When the recognition comes there will be a large home market for mineral fertilizers. An enterprising industrial corporation will usually find it advantageous to work up a home market for its by-products and to create an active demand by a judicious educational campaign. At the present time both Ontario and Quebec offer a very promising field for a campaign of this sort.

It is probable that in the near future economical commercial methods will be devised whereby sulphur can be extracted from the sulphur dioxide by-product gases of a smeltery. Certain laboratory reactions are already known which afford hopes that this expectation will be realized. Sulphur dioxide gas cannot be shipped in quantity economically even in liquid form in iron cylinders, the combined weight of liquid and container being nearly the same as that of an equivalent quantity of raw ore, while it is more difficult to prepare for transportation because the gas has first to be condensed under pressure. It can probably be handled economically in liquid form in tank cars. Sulphur can easily be handled, and possibly can be produced at less cost than the natural sulphur now on the market.

In conclusion it may be stated that if a portion of Quebec copper-sulphur ores is utilized in the district where they are produced for the manufacture of sulphite pulp or for any other purpose, the mine owners will not be the only persons benefited. At the present time a very considerable percentage of the value of the ore is paid out for transportation, chiefly through a foreign country. Most of this will be saved: not, however, at the expense of the railways, because the higher freight rates on the finished products of a sulphite pulp mill will more than compensate for

the small decrease in freight on raw ores. A large portion of the increased value of the material, when marketed as a finished product, will go to the mill operatives. This in turn will benefit that portion of the population which is engaged in producing food products. In brief, under present conditions, a very large percentage of the value of the finished products made from raw materials produced in Quebec, benefits other districts, and people not residents of that Province; the imperative demand which exists for products which are being manufactured from these raw materials ensures a large and ready market if these materials are converted into finished products in their home district.

### NICOLET ANTIMONY MINE.

Under special instructions, a visit was made to the old antimony mine on lot 56, range I, South Ham. The old workings were not accessible, because the adit was blocked by clay and water, and the shafts were partly filled with snow and ice. As far as could be ascertained from a surface examination, the ore consists of metallic antimony, together with stibnite, and smaller amounts of other antimony-bearing minerals. The associated rock is chloritic schist, striking nearly northeast, in which numerous lenses of quartz, usually almost black in colour, are found. In width these vary from narrow veins to lenses about 2 feet across. In the vicinity of the mine the quartz veins examined were all characterized by swells and rolls—narrowing to one-quarter of an inch, or even disappearing, or widening to 2 or 3 inches.

In the vicinity of the old mine-workings the rocks are pretty well shattered by joints, and there appears to have been a slight jostling of the joint blocks: the cavities thus formed have been filled with quartz. Such veins are very irregular in both dip and strike; presumably, some of the spaces which they now occupy were open spaces when the vein matter was introduced, because some of the quartz veins show comb structures. Originally, also, there appear to have been bands of sulphides (iron and possible copper) between the quartz bands. In a vein 1 inch wide, six bands of quartz and five bands of red oxide of iron were noted: the latter about 25 per cent of the whole. Occasional vugs lined with quartz crystals, and containing crystals of antimony minerals, stibnite ($Sb_2S_3$), kermesite ($2Sb_2S_3,Sb_2O_3$), and senarmontite ($Sb_2O_3$) still exist. Stibnite was noted both in plate-like crystals, and in minute acicular crystals. Kermesite in small tufts of acicular crystals, and more rarely, a yellow tinted senarmontite, occur. In a few instances metallic particles were found in the quartz of the veins. In the rock adjacent to the veins more abundant metallics were noted, and on breaking the rock a large proportion of the metallics are seen to be distributed as thin plates along fracture planes—in some places producing a bright metallic lustre over a considerable area. Metallics in thicker particles also occur scattered through the rock. The ore in the rock seems to be most abundant near the veins. In many places, through the zone supposed to be mineral bearing, no visible particles of ore could be found. In some places impregnated rock was found adjacent to a fracture in which no quartz occurs.

The strike of the structural planes of the schists lies between N 40° E and N 50° E magnetic, or, towards the ridge which lies north of the mine, and the front of which runs nearly east and west. The presence of a waste cover makes it impossible to study the area for any distance along the strike. The prospecting work has all been along the face of the hill, or nearly at right angles to the strike. Between the most easterly shaft and the most westerly one, the distance is nearly 300 yards. Prospecting pits are to be found for some distance west of the main shaft, and much costeaning has been done.

North of the shafts the hill referred to above forms a dome-like ridge about a quarter of a mile in length. It is composed of basic plutonic rock, now serpentine on the side next the schists, but consisting of a diabase on the north side. About 850 feet southeast of the east end of this ridge is another similar but smaller dome.

Nearly half a mile south of the shafts—on the opposite side of a valley—lies a large area of serpentine rocks, which gradually pass into diabase farther south. The two small dome-like ridges in the immediate vicinity of the mine carry included fragments of schists in the upper surface, and they were probably forced into the schists as laccolithic masses from below. This circumstance makes it extremely probable that the band of schists has no great depth.

The mineralized area or zone lies close to the contact between the schists and the intruded serpentines. It is thus probable that other mineralized areas may occur in the same district along the line of contact. While the shape of the intruded masses makes it possible that the ore-bearing band may be of no great depth, there are no data at present obtainable from which it would be possible to determine what that depth is. On the other hand, it is also possible that the mineralized zone may follow the supposed curved surface of contact between the schists and serpentine and that a very considerable area beneath the schists may carry antimony minerals.

In 1881 there were two shafts on the property, 60 feet and 100 feet in depth, respectively, and 250 feet of drifting. Assays of the ores as they occurred in these shafts and drifts are said to have shown from 5 to 7 per cent of antimony. A small experimental plant was in operation in that year. The ore was crushed by stamps and then washed upon a broad travelling belt, the lighter particles being washed off, while the heavier were deposited at the end of the belt. This plan does not appear to have been very efficient and the losses in the tailings were high.

A number of small trial shipments were made from the property in 1881. The returns from these shipments show an antimony content of about 7 per cent. Experimental work on a Krom machine produced concentrates assaying from 30 per cent to 49 per cent antimony, in different experiments. In one case, what are called 'extra concentrates' were obtained—assaying 53·9 per cent antimony. Concentrates on a Hastings machine assayed 37·13 per cent. The ore was found to contain about 4 ounces of silver to the ton of 2,000 pounds. No gold has been reported.

In 1886, the property was purchased by Dr. James Reed. Under his control an adit was driven into the side of the hill to cut the deeper shaft near the bottom. This adit is about 304 feet in length. A small amount of drifting was done in later years, but no information is now available as to the results obtained.

The thin plate-like character of the particles of metallic antimony, as seen on the fracture planes of the rock near the surface, undoubtedly will make concentration difficult. While the concentration experiments made on the ore from the drifts and shafts seem to have yielded a product that is commercially valuable, no data whatever are available as to the costs. Nothing can be learned about the quantity of rock handled in obtaining this ore, and the weight of the ore mined is not known. Further information is needed with respect to the underground conditions; the surface showings are not of commercial importance.

### SPALDING IRON LOCATIONS.

Some deposits containing hematite and magnetite have recently been found in the township of Spalding, about seventeen miles from Lake Megantic. At present the prospect can be reached by driving fourteen miles from Lake Megantic to an old mill located on lot 16, range VII, Spalding township, the last mile or so of the drive being through the fields over an old lumber road. From this point the distance to the prospects is about two and one-half miles, by old lumber roads that can be driven over in winter. The prospects are located in the midst of a dense wood and would be difficult to find without guides.

At the prospects the surface is covered with soil, leaves, moss, and roots, only a few outcrops can be found, and exploration will have to be carried out by stripping and drilling, provided it can be shown that this is worth while. A fairly commodious

log shanty has been erected near one group of prospects, near the east corner of lot 10, range VIII.

In this group of prospects, banded quartz, stained red with hematite or black with magnetite, and closely resembling in general appearance the banded jasper of western Ontario, is found in several outcrops. These outcrops are usually in the form of low domes, elongated in the direction of the strike, approximately N 40° E.

Considering the outcrops in order from southeast to northwest:—

The most southeastern outcrop occurs on lot 11, range IX. The rock has been exposed by stripping over an area about 50 feet long by 6 feet wide. It consists of banded quartz irregularly streaked white and red, with occasional bands of black magnetite—a dark red colour predominating. No ore of consequence was seen, and the actual size of the band of iron range rock is uncertain.

The next band occurs about 200 yards northwest of this, on lot 10, range IX, near the northwest line of the lot. It is probably about 20 feet wide, and the structural planes dip towards the northwest at about 70°. Both hematite and magnetite occur with the quartz in this outcrop, the iron range rock being a mixture of the two ores with quartz—some of the ore bands are nearly 2 inches in width; but by far the greater portion of the outcrop is quartz. On the northwest side of the outcrop the iron range rock is seen in actual contact with the adjacent country rock—a green schist. The inter-relations of the two suggest that the schist has first come into contact with the iron range rock as an intrusive, though this relationship is not proven.

About 100 yards farther northwest a number of large loose blocks of banded jasper, mottled red and white—red predominating—show that another band probably exists in this locality, in the east corner of lot 10, range VIII. No stripping has been done, and no ore can be seen. This band has a minimum width of 30 feet. On the east side of this band is an outcrop of grey schist, slightly different in appearance from the schist first found in contact with the second band of iron formation. About 50 yards northwest, a fourth band of iron formation, with a minimum width of 6 feet, has been uncovered in several places. No ore can be seen. This last outcrop is within 50 yards of the camp. Northeast about 250 yards, on lot 9, range IX, there are several outcrops of green schist.

There are thus at least four bands of iron range rock in this locality, separated by bands of green chloritic schists. Very extensive stripping will be required to determine the size of these bands. The fact that some of them contain narrow bands of good iron ore does not necessarily imply that concentrations of similar ore in commercial quantities occur in the locality. No commercial ore has been found, and assays of fragments from the ore bands in these rocks are not only greatly misleading, but their cost is an unnecessary expenditure.

Nearly half a mile northeast of the camp on lot 7, range VIII, near the southeast end of the lot, other iron range rocks have been found. The rocks form the southwest side of the valley of Fox creek.

The rock itself is a quartzite impregnated with magnetite, an assay of the rock showing over 15 per cent iron oxide. In this quartzite richer seams of magnetite and small clear quartz veins occur. The outcrops are found along the face of a steep slope, which in places becomes a cliff. The rock is greatly metamorphosed, and breaks up readily into large thin plates; the structures are nearly vertical and the strike is approximately northeast. The quartzite itself has been mistaken for iron ore; but no commercial ore had been found at the time of my visit.

The character of this last deposit makes it a very easy matter to determine the length and width of the magnetite-bearing body of quartzite, and to determine if concentration of the magnetite has occurred in any place along the iron range. In the case of the other bands of iron range a trial would be required to determine if they carry sufficient magnetite to render magnetometric methods serviceable in ascertain-

ing their nature and extent. Blind exploration of these deposits, without preliminary investigations by the latest scientific methods, is a waste of time and money. From the evidence at present available, no one can say whether iron ores in commercial quantity occur in this vicinity.

## II

## NOTES ON AN OCCURRENCE OF TALC AND SOAPSTONE IN MEGANTIC COUNTY, QUEBEC.

Talc has been found on lots 1 and 2, Craigs Road Range (in range VII, of Ireland) and also on lot 1, range I of the adjoining township of Inverness. The greater portion of the district in the vicinity of these discoveries is obscured by a heavy soil cover, though there are numerous rock exposures on the southwest part of the lots in the Craigs Road Range. It is probable that further investigation will show the existence of talc on other portions of these and adjoining properties.

Massive soapstone of a greenish-grey tint occurs in all the discoveries. On lot 1, range I, of Inverness, two pits about 4 and 12 feet in depth, respectively, have been dug. On Craigs Road Range lots, similar soapstone has been found in at least five localities, and a little excavation work has been done. In neither locality is the work sufficient to demonstrate the extent and character of the deposit. On the Craigs Road lots the soapstone appears to occur along a series of shear zones in a highly altered basic igneous rock, now largely chlorite, originally, possibly, a diabase.

The Craigs Road property also shows a number of veins of sea-green crystalline talc traversing the soapstone in several directions. These veins vary in width from about half an inch to over 4 inches. In length, individual veins have been traced for 12 feet or more; but their extent and distribution is not at present known. A crystalline rhombic carbonate—probably dolomite, is found in these veins, associated with the crystalline talc. Occasionally, masses of the carbonate and talc more than a cubic foot in volume are found.

The locality is about thirteen miles from Black Lake station on the Quebec Central railway, and about two and a half miles from the proposed location of the new railway between Levis and Sherbrooke, via Lloyd's mills. Lot 1, range I, Inverness is the property of R. J. Briggs, Clapham, Que., and lots 1 and 2, Craigs Road Range, Ireland township, are under the joint ownership of C. V. M. Temple, 175 Spadina Road, Toronto, Charles Campbell, Woodside, Que., and W. J. Porter, Clapham, Que., Mr. Temple having the control of the property.

These properties are deserving of careful and systematic exploration, to determine the nature and extent of the deposit.

# ON A NUMBER OF IRON ORE PROPERTIES IN NORTHEASTERN ONTARIO.

*Howells Fréchette, M.Sc.*

## WHITE LAKE.

Certain lots on the east side of White lake have been reported at various times as showing hematite. These lots were visited and searched. Even with the aid of men familiar with this section of the country, only a few showings of iron ore could be found. Among the reputed deposits not found was one mentioned by Dr. Ells, on page 64 J, of the Geological Survey Report, 1901, as the Robertson mine, on lot 1, concession I, of Bagot township, Renfrew county.

## FAHEY OR BELL MINE.

The Fahey mine is situated on lot 26, concession XI, of Darling township, Lanark county, about 1,000 feet east of the shore of White lake. A shaft had been sunk into a vein of hematite ore to a depth of a little over 20 feet, but at the time of my visit was full of water. There were also some old trenches across the vein. These were cleared out and several new trenches were dug.

The ore was exposed in a trench 40 feet northeast of the shaft, showing the vein to be 15 feet wide, and in another 50 feet southwest of the shaft the vein was uncovered for a width of 10 feet, without touching either wall. Beyond these two trenches the ore could not be reached on account of the nature of the covering. The vein strikes N 40° E[1], and is almost vertical. Both walls are crystalline limestone. The ore is of uniform character, high in lime and low in silica, sulphur, and phosphorus. This would be an excellent ore for mixing purposes.

An average sample, taken from the ore pile at the old shaft, gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 2·44 |
| Iron | 34·73 |
| Phosphorus | 0·029 |
| Sulphur | 0·054 |
| Lime | 20·30 |
| Manganese | 0·32 |
| Magnesia | 3·44 |

About one and one-eighth miles southwest of the Fahey pit, an iron-bearing zone is encountered, the general strike of which is N 23° E. This was traced for about one mile.

The northernmost exposure is about 1,000 feet northeast of the line between concessions XI and XII, on lot 23, where a banded ferruginous and highly siliceous rock is exposed on the face of a hill for a width of about 35 feet. In this are small veins of hematite not exceeding 4″ wide.

The following is a partial analysis of this ferruginous rock:—

| | Per cent. |
|---|---|
| Insoluble | 35·7 |
| Iron | 17·0 |

[1] All bearings indicated in this report— unless otherwise stated—are astronomical

Following along the strike other outcroppings were found at 125 feet, 625 feet, 1,200 feet, 1,500 feet, and 3,000 feet from the above-mentioned outcrop.

Samples taken at the two last-mentioned outcrops give the following percentage for insoluble matter and iron:—

| | Per cent. |
|---|---|
| Insoluble | 60·00 |
| Iron | 12·40 |

and

| | |
|---|---|
| Insoluble | 54·52 |
| Iron | 3·90 |

The width at these two points was about 30 feet.

### LOT 23, CONCESSION XI, DARLING.

Eleven hundred and fifty feet southwest from the last-mentioned exposure, a pit had been sunk about 7 feet into hematite, at a point where a vein had been enlarged by the crossing of another small vein. The body at this point is about 30 feet by 35 feet. The vein itself is only 2 feet wide.

An average sample gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 3·20 |
| Iron | 62·52 |
| Phosphorus | 0·44 |
| Sulphur | 0·004 |

Following in a direction S 35° W small veins of hematite are found at several points for a distance of 1,400 feet, and also along the same line on the opposite side of a small bay of White lake. A sample taken from a 2 ft. vein at this point gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 9·51 |
| Iron | 60·10 |
| Phosphorus | 0·127 |
| Sulphur | 0·035 |

### YUILL MINE.

This mine is situated on the southwest half of lot 25, concession V, of Darling township; about one mile and a half south of the head of White lake.

Since 1889, when this property was first operated, a little over 2,000 tons of high grade magnetite have been mined.

This pit is about 100 feet long, by, from 30 to 40 feet wide, and a little over 70 feet deep. It was impossible to make a satisfactory examination of the pit owing to the presence of about 30 feet of water. At the east end, near the water level, ore can be seen—about 6 feet wide; while at the west end, there is a face of ore about 10 feet in width.

The ore body dips steeply to the south, having a foot-wall of diorite and schist, and a hanging-wall of crystalline limestone. Small veins of pyrites occur in the ore, but in a manner easily separated by hand picking.

Magnetometric readings taken in the vicinity of the mine do not indicate the presence of nearby deposits, nor the extension of the ore body in which the mine is located.

A sample from the mine and from the ore dumps gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 10·08 |
| Iron | 63·00 |
| Phosphorus | 0·025 |
| Sulphur | 0·006 |

PROPERTIES ON THE DARLING ROAD.

A number of lots were examined on both sides of the Darling road, in the south-western end of the township of Darling, Lanark county. These lots have been reported as showing iron ores. Most of the prospecting was done from twenty to thirty years ago, and in a number of cases the finds had not been visited since then.

Owing to the roughness of the country, and the great changes due to forest fires and dense second growth, it was difficult, and in a few cases impossible, to find these occurrences.

*Lot 20, Concessions IV and V, Darling Township.*

On the top of a range of hills, which crosses the northeast end of lot 20, concession IV, the amphibolite rocks were found to be impregnated with magnetite; but a magnetometric survey shows the impregnation to be very irregular, hence it cannot be considered of commercial importance: although the amount of iron reaches 50 per cent, or more, in places.

To the north of this, on the lower ground, a magnetometric survey was made, extending onto lot 20, concession V. This shows several large areas of moderately high readings.

The ore is not a well-defined mass, but merely an enrichment of the magnetite in the amphibolite rocks. The dimensions of the workable ore body can only, after carefully studying the analyses of a great number of samples taken at close intervals over the deposit, be arrived at by considering the market value of the ore and the cost of mining and concentrating.

The ore is too low-grade for direct reduction, so would have to be subjected to magnetic concentration.

Two general samples taken from the surface give the following analyses:—

| | Per cent. |
|---|---|
| Insoluble | 53·00 |
| Iron | 24·21 |
| Phosphorus | 0·468 |
| Sulphur | 0·031 |

and

| | |
|---|---|
| Insoluble | 54·11 |
| Iron | 23·70 |
| Phosphorus | 0·437 |
| Sulphur | 0·091 |
| Titanic acid | 0·69 |

*Lot 22, Concession IV, Darling Township.*

On lot 22, concession IV, several pits have been opened on small pockets of magnetite, and some ore shipped; but judging from magnetometric readings, these deposits cannot be considered of any importance.

*Lot 22, Concession V, Darling Township.*

A pit, said to be on lot 22, concession V, was visited and examined.

This pit had been sunk to a depth of about 20 feet into a small pocket of fine-grained magnetite with a small vein leading to it.

The following analysis is from a picked sample:—

| | |
|---|---|
| Insoluble | 8·34 |
| Iron | 61·17 |
| Phosphorus | 0·046 |
| Sulphur | 0·042 |

*Lot 22, Concession III, Darling Township.*

Southwest of the Darling road, on the southwest half of lot 22, concession III, is a large hill covered with broken rock and sandy soil. Some of these rocks show a considerable percentage of magnetite disseminated through them.

Along the north side of this hill, there are a number of large trenches which were opened about seventeen years ago and from which ore was shipped. These trenches have caved in and trees are now growing in the bottom of some of them. No reliable information could be obtained as to whether the ore came from loose fragments or from the solid formation.

Magnetometric readings taken in the vicinity of these trenches were low and irregular, and do not indicate the presence of a large body of magnetite.

On the opposite side of the Darling road, on the northeast half of the same lot, a pit was recently opened on a small pocket of magnetite.

*Lot 17, Concession II, Darling Township.*

At the northeast end of lot 17, concession II, is a high hill of amphibolite which extends across the lot. The rocks of this hill are impregnated in a great many places with magnetite, the richness varying from mere traces to a fair grade of ore. At the west end of the hill magnetometric readings indicate the presence of a fairly large and continuous body of low grade ore, which would require magnetic concentration. No satisfactory sample could be obtained at this point. The iron would probably run about 30 per cent.

To the southwest of the hill traces of hematite were observed in the neighbourhood of crystalline limestone.

*Lot 18, Concession XI, Bagot Township, Renfrew County.*

On lot 18, concession XI of Bagot, in the village of Calabogie, magnetic disturbance was observed near the main road which follows the west shore of Calabogie lake.

A magnetometric survey was made which indicates the existence of magnetite in a series of small pockets extending for about 600 feet along the road and crossing it.

*Lot 18, Concession IX, Bagot Township.*

On lot 18, concession IX, about two miles by road from the last-mentioned deposits, several pits have been sunk into iron ore.

At the extreme northeast end of this lot a pit had been opened in the side of a small hill. It shows a vein of magnetite ranging from 1½ to 3 feet in thickness, dipping to the south at 35°. Both walls are of crystalline limestone. The magnetite is mixed with hematite.

Thirty feet south of this pit a shaft had been sunk, but owing to the presence of water it could not be examined. The magnetic attraction in the vicinity was not great.

About one-third of the distance along this lot another shaft had been sunk. This was examined, showing the ore to be hematite, containing a little magnetite. The ore is much intermixed with rock, and is only 2 or 3 feet in thickness.

The ore is in crystalline limestone, underlain by quartzite and fine-grained hornblende schist.

At the southwest end of this lot there are also showings of magnetite and hematite.

### *Lot 23, Concessions V and VI, Bagot Township.*

A magnetometric survey was made on parts of lot 23, concession V, and lot 23, concession VI, where some prospecting had been done.

The readings indicate the presence of a number of small bodies of magnetite, dipping very slightly to the south, the maximum thickness being about 6 feet.

A sample taken from various parts of these deposits gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 37·08 |
| Iron | 31·02 |
| Sulphur | 0·167 |
| Phosphorus | 0·312 |

### *Lot 28, Concession VI, Bagot Township.*

On lot 28, concession VI, to the southeast side of the road which runs through that lot, a pit had been sunk to a depth of 18 feet into magnetite. The ore is found in alternating layers of high grade magnetite and a gneissic rock carrying magnetite. It dips to the south at about 15°. In the pit the ore is exposed for a thickness of 8 feet, but the foot-wall was not uncovered.

About 100 feet to the east of the pit there is a mass of gneiss; and to the north, a large exposure of crystalline limestone.

No magnetometric survey was made.

The following analysis is from an average sample taken in the pit:—

| | Per cent. |
|---|---|
| Insoluble | 38.00 |
| Iron | 42·81 |
| Phosphorus | 0·006 |
| Sulphur | 0·068 |
| Titanic acid | 1·37 |

### *Lot 13, Concession I, Blithfield Township, Renfrew County.*

On lot 13, concession I, of Blithfield, about three miles south of Calabogie, in a side rockcut of the Kingston and Pembroke railway, a vein of magnetite, dipping at 35° to the east, is exposed for about 75 feet in length and 8 feet in height, without showing the foot-wall.

The face of the rockcut is a little over 50 feet high, with a rising hill to the east. On this hill the magnetic attraction is weak; but numerous readings taken along the edge of the swamp to the west of the railway, and in some places as much as 200 feet from it, varied from –17 to –22 degrees.

More readings could not be taken on account of the swamp.

An average sample of the exposed portion of the vein gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 37·40 |
| Iron | 38·80 |
| Phosphorus | 0·013 |
| Sulphur | 0·179 |
| Titanic acid | 4·96 |

*South Canonto Township, Frontenac County.*

On lot 26, concession VI, near the line dividing concession V and concession VI, a pit had been opened on a vein of magnetite. At the time of my visit it was full of water. An outcrop near the pit shows the ore to be fairly free from intermixed rock. A sample taken from a small pile of ore near the pit gives the following analysis:—

| | Per cent. |
|---|---|
| Insoluble | 31·60 |
| Iron | 44·00 |
| Phosphorus | 0·045 |
| Sulphur | 0·436 |
| Lime | 0·70 |
| Titanic acid | trace. |
| Manganese | 0·10 |

The vein which runs north-south was traced by means of the mining compass for about 250 feet onto lot 26, concession V. It appears to be about 10 feet in width.

Several hundred yards from the pit, another smaller vein was also seen.

In addition to the lots already mentioned, thirty-four other lots were visited and examined, twenty-eight of which were examined for iron ores. These are not commented on in this report for the following reasons:—

(1) From one cause or another the reported occurrences could not be located.

(2) The reported ores turned out to be some worthless mineral or rock.

(3) Only mere traces of ore could be found.

(4) Where the lots were examined for extension of a series of deposits and no discovery made.

(5) Where mines reported on by Mr. Ingall in his report on the iron ores along the Kingston and Pembroke railway were visited and no additional information was obtained.

### MARBLE.

Two lots, namely, lot 6, concession III, and lot 7, concession IV, Darling, were visited to obtain data of the marble workings for the Division of Mineral Resources and Statistics.

### PYRITES.

Lot 5, concession IV, Darling, was visited. Here a mine had been worked some ten years ago for pyrites.

The vein is almost vertical, about 8 feet wide and running northeast and southwest; the east wall of which is amphibolite and the west wall crystalline limestone. It was impossible to determine the length of the vein without digging deep trenches. A tunnel runs along the vein for about 100 feet.

CELESTITE.

Lot 7, concession X, Bagot, was visited and a deposit of celestite examined. The celestite occurs in a vein running northeast and southwest. It was traced for 500 feet; its maximum width is about 18 feet.

The vein seems to be free from included rock and impurities. The following analysis is from a sample from this vein, recorded in the Geological Survey Annual Report (New Series), Vol. XI, page 9 R.

| | Per cent. |
|---|---|
| Sulphuric anhydride ($SO_3$) | 42·09 |
| Strontia (SrO) | 48·30 |
| Baryta (BaO) | 9·44 |
| Lime (CaO) | Trace. |

In conclusion the author wishes to express his obligation to Mr. R.R. MacGregor, of Calabogie, Mr. J. Stewart, of Waba, and Mr. J. Bell, of Arnprior, who kindly furnished information and otherwise aided in the prosecution of the work. During the field work he was ably assisted by Mr. L. H. S. Pereira, of the staff of the Mines Branch, Department of Mines.

# ON THE GYPSUM RESOURCES OF NOVA SCOTIA.

*W. F. Jennison, M.E.*

During the year 1909, I continued my work of investigating the gypsum resources of Nova Scotia and New Brunswick; including the deposits of the Magdalen islands, in the Gulf of St. Lawrence.

The United States being a large producer of both the crude and the manufactured article, it was deemed advisable that I should visit the industrial centres of this business in that country with a view to obtaining information relative to the modern methods of manufacturing, together with the uses and cost of manufacturing the same. This trip was undertaken in the early part of the year and was highly productive.

The greater amount of gypsum produced in the United States, together with the crude rock imported (principally from Canada), is manufactured by grinding and partial or complete calcination into various plasters, such as plaster of Paris, stucco, cement plaster, flooring plaster, hard finish plaster, etc. The extra refined grades of plaster are used in dental work (11,648 tons were used in the United States for this work alone in 1907). It is also used as a cement for plate glass grinding. A steadily increasing demand exists for this material as a retarder in Portland cement. Considerable quantities are ground and used without calcining as land plaster or fertilizer, while smaller quantities are used in the manufacture of paint and paper, imitation meerschaum and ivory, and as an adulterant. The pure white massive variety, known as alabaster, is much used by sculptors for interior ornamentation. The crude rock is also cut or carved, dehydrated, hardened, and polished for various ornamental uses, in place of marble, and is known as ariston.

Field work for the season began early in June, and continued, weather permitting, throughout the whole season. Over 100 deposits of commercial value have been examined and sampled for analysis.

The gypsum deposits examined occur, without exception, at the summit of the lower Carboniferous series. In this respect they resemble the deposits of the United States, occurring in the lower peninsula of Michigan, in Montana, and in Virginia.

In many instances very little evidence of disturbance is shown, the beds lying quite horizontal or having quite a low angle of dip. There are, however, at some points, especially in the island of Cape Breton, evidences of disturbance of considerable importance, where the beds are crumpled, folded, or tilted to extreme angles.

Many of these deposits follow immediately upon the deposits of carbonate of lime. In some cases the carbonate is so closely associated with the sulphate that it is difficult to draw any line of demarcation; one graduating with diminishing or increasing prominence into the other. At Broad cove, Inverness county, N.S., bunches or patches of pure carbonate of lime may be seen encased in gypsum. At Tom river, Richmond county, N.S., a vein of carbonate of lime about 2 feet wide may be seen in an exposure of gypsum, having a height of from 20 to 30 feet, and cutting it transversely with very distinct walls. The following analysis shows the quality of this vein:—

| | Per cent. |
|---|---|
| Lime | 53·13 |
| Ferric oxide and alumina | 0·50 |
| Sulphuric anhydride | 1·36 |
| Carbonic anhydride | 40·99 |
| Water, loss on ignition | 1·02 |
| Insoluble mineral matter | 3·69 |
| | 100·69 |

While samples from the wall rock give the following results by analysis:—

| | Per cent. |
|---|---|
| Lime | 33·20 |
| Ferric oxide and alumina | .. |
| Sulphuric anhydride | 46·28 |
| Carbonic anhydride | .. |
| Water, loss on ignition | 20·69 |
| Insoluble mineral matter | 0·16 |
| | 100·65 |

These deposits present much variety of colour and texture. The greater part of the rock may, in texture, be classed as compact or cryptocrystalline, with lesser quantities as granular or saccharoidal; but in some places considerable quantities of selenite and the fibrous variety occur. Crystals of selenite are often found disseminated irregularly through other varieties; usually in groups or bunches, sometimes in veins.

Anhydrite also occurs in extremely variable proportions in many of the deposits. The irregularity of the occurrence of this mineral—which is practically valueless—with the gypsum, often interferes materially with the economic operation of the quarries.

The following brief description will serve to show the importance of many of the deposits.[1]

No. 1.—East bay, Cape Breton county, N.S.—

Situated about two and a half miles from deep water shipping at the head of East bay, on the Bras d'Or lakes, there is a total gypsiferous area of 2·40 square miles, showing exposures from 20 to 60 feet in height, covering an area of several acres. The greater quantity is a very pure, compact, soft, white variety, with lesser quantities of soft, white granular.

The following analyses show the results of average samples taken from this deposit:—

| | I Per cent. | II Per cent. |
|---|---|---|
| Lime | 32·87 | 33·10 |
| Sulphuric anhydride | 46·07 | 45·95 |
| Water, loss on ignition | 20·89 | 20·85 |
| Insoluble mineral matter | 0·12 | 0·07 |
| | 99·95 | 99·97 |

No. 2.—North side East bay, Cape Breton county, N.S.—

On or near the shore at this point occur a number of small deposits of more or less importance. They comprise a total gypsiferous area of 281·6 acres. The greater part of this area is covered with a heavy overburden of clay, and the exposures are small and irregular.

[1] Analyses by Mr. F. G. Wait, Chief Chemist, Mines Branch.

The rock is principally a compact variety of various colours: white, dark grey, grey, blue, black, and pink.

Analysis of the dark variety shows the following results:—

| | Per cent. |
|---|---|
| Lime | 31·62 |
| Sulphuric anhydride | 42·96 |
| Water, loss on ignition | 20·44 |
| Ferric oxide | 0·95 |
| Insoluble mineral matter | 3·60 |
| | 99·57 |

No. 3.—Tom river, Richmond county, N.S.—

On the southeast side of Great Bras d'Or lake, in a gypsiferous area of 2·7 square miles—comprising Campbell cove, Hay cove, and McNab creek—occur several outcrops of gypsum. Some of these outcrops consist of a very excellent, snowy white, compact variety, resembling alabaster; while others, especially at Tom river, show an excess of lime. The whole is reasonably accessible to water shipment.

The following analyses show the average quality of the rock:—

| | I | II | III |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent |
| Lime | 32·95 | 34·04 | 33·02 |
| Sulphuric anhydride | 46·64 | 44·28 | 46·68 |
| Water, loss on ignition | 20·93 | 21·07 | 20·91 |
| Insoluble mineral matter | 0·13 | 0·67 | 0·26 |
| | 100·65 | 100·06 | 100·87 |

No. 4.—Madame island, Richmond county, N.S.:—

On the north side of Madame island, and the south side of Lennox passage there occurs a large gypsiferous area comprising 3·77 square miles. The outcrops of gypsum in this area having most prominence are situated about one and a half miles west of Lennox Ferry Landing, and about one mile from the shore. At this point the exposures are several acres in area, and have a height of from 30 to 70 feet. Here, years ago, H. C. Higginson, of Newburgh, New York, operated a quarry and exported large quantities of the crude material to the United States. The gypsum is a white, compact variety; but it has irregularly associated with it much anhydrite. The occurrence of this mineral had, no doubt, much to do with closing the quarry. There still remain large quantities of good gypsum, and this, together with excellent, natural shipping facilities, and an increasing demand, should be an inducement to re-open and operate this extensive area.

Analysis:—

| | Per cent. |
|---|---|
| Lime | 33·33 |
| Sulphuric anhydride | 45·32 |
| Water, loss on ignition | 20·92 |
| Insoluble mineral matter | 0·22 |
| | 99·79 |

No. 5.—Malagawatchkt, Inverness county, N.S.—

On the south side of Denys basin is a narrow gypsiferous area, skirting the shores from McKenzie brook on the northwest to about half a mile southwest of Matheson's wharf, and continuing southwest by numerous small islands and penin-

sulas to West bay. In this area numerous outcrops of gypsum are seen: at Plaster island; on the River Denys road; George island; Green island, and Floda island.

Many of these outcrops are of little importance, being low, and having but small quantities above sea-level. Several, however, have sufficient prominence to be considered as available supplies. The exposure on Donald McKinnon's farm, River Denys road, has a height averaging 50 feet, with a length of 275 feet. This deposit and its extension two and a half miles northwest to Plaster island, shows probably the most important deposit in the whole area. At Plaster island the exposure is from 10 to 40 feet in height on the shore, and covers an area of four or five acres.

In texture and colour this rock is a soft, white, compact variety, having some anhydrite associated with it.

The following analyses are the results of average samples: No. 1 from the McKinnon outcrop, and No. 2, from the Plaster Island outcrop.

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 33·33 | 33·70 |
| Sulphuric anhydride | 45·00 | 45·25 |
| Water, loss on ignition | 20·75 | 20·78 |
| Insoluble mineral matter | 0·33 | 0·40 |
| | 99·41 | 99·77 |

No. 6. South side of Whycocomagh, Inverness county, N.S.—

Bounded on the northwest by St. Patrick channel, and on the southeast by Denys basin, is situated a gypsiferous area of 6·78 square miles.

The surface indicates that the greater part of this is underlain by gypsum, and covered by an overburden of clay, varying in thickness. Several exposures are seen in this area, the greater part of which is a white compact variety with lesser quantities of granulated white and grey, with some crystals of selenite. Very little anhydrite is shown.

Analyses of an average sample show—

| | Granulated. Per cent. | Compact. Per cent. |
|---|---|---|
| Lime | 33·33 | 33·73 |
| Sulphuric anhydride | 45·72 | 46·20 |
| Water, loss on ignition | 20·85 | 20·85 |
| Insoluble mineral water | 0·19 | 0·06 |
| | 100·09 | 100·84 |

No. 7.—Washabuck peninsula, Victoria county, N.S.:—

This area includes the deposits at McKinnon harbour, Ottawa brook, Washabuck river, Nineveh, Little Narrows, Maciver point, Deadman point, McKay point, Boulaceet harbour, Lieutenant pond, Iona, Jamesville, and Red point. Total area 25·54 square miles. Here all varieties of texture and colour may be found. The exposures are many and large. Anhydrite occurs frequently, outcropping in large irregular masses. This is especially true at Nineveh and at Washabuck; the former having a perpendicular face of 60 to 80 feet, and a length of over 800 feet. At the latter place it shows, on a road leading from Washabuck river to Little Narrows, for nearly a mile in width.

At Ottawa brook, the Newark Lime and Cement Company of Newark, New Jersey, U.S.A., started operations in 1908. They have opened up several deposits and built a railway connecting them with their shipping pier, constructed on the north side of Great Bras D'Or lake.

The rock at some places, where opened up, although a soft, white, compact variety, shows much disturbance, being badly fractured and folded. A dark carbonate of lime is also seen in close conjunction with the gypsum. The composition of these rocks is shown in the following analyses: Sample No. 1, Gypsum; Sample No. 2, Limestone:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 33·50 | 51·27 |
| Magnesia | .. | 0·46 |
| Ferric oxide | .. | 0·30 |
| Sulphuric anhydride | 45·32 | 0·04 |
| Carbonic anhydride | .. | 40·73 |
| Water, loss on ignition | 21·15 | 0·86 |
| Insoluble mineral matter | 0·10 | 6·34 |
| | 100·07 | 100·00 |

At McKinnon harbour the measures are nearly all concealed. About one and a half miles east of the harbour there is an exposure showing a face of good white compact rock, about 30 feet in height. The samples from this show the following composition:—

| | Per cent. |
|---|---|
| Lime | 33·13 |
| Sulphuric anhydride | 46·04 |
| Water, loss on ignition | 20·70 |
| Insoluble mineral matter | 0·36 |
| | 100·23 |

On the south side of Red point, and between McKinnon point and Oyster pond, occurs in the bluff of the shore a mixture of gypsum and limestone, associated with selenite, having large transparent plates or crystals, covered with a very plastic, smooth, red clay. The colour of the rock varies from a dark grey, and mottled, to a pure white, having a compact texture.

The clay carries particles of gypsum, and might be classed as gypsite. The following are the results of analyses of samples taken from this deposit:—

| | I | II | III | IV |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime | 51·88 | 38·20 | 33·67 | 33·67 |
| Ferric oxide and alumina | 0·43 | trace | trace | .. |
| Sulphuric anhydride | 0·96 | 42·16 | 44·77 | 45·44 |
| Carbonic anhydride | 40·76 | 2·49 | .. | .. |
| Water, loss on ignition | 0·57 | 20·83 | 20·80 | 20·92 |
| Insoluble mineral matter | 5·40 | 1·60 | 0·40 | 0·07 |
| | 100·00 | 100·28 | 99·64 | 100·10 |

No. I.—Dark grey, with particles of selenite.
II.—Grey mottled.
III.—Pure white.
IV.—Selenite.

At Little Narrows (south side) on the properties of M. J. McAskill, and widow McAskill, very large exposures are seen. At the latter the face is about 100 feet high,

and over 600 feet long. The rock is an excellent quality of soft, white, compact variety, with but few irregularities. It is situated about one mile from the shipping point on St. Patrick channel.

The composition is shown by the following analysis:—

| | Per cent. | Per cent. |
|---|---|---|
| Lime | 33·30 | 33·67 |
| Sulphuric anhydride | 46·00 | 46·00 |
| Water, loss on ignition | 21·16 | 20·70 |
| Insoluble mineral matter | 0·24 | 0·20 |

On the north side, Little Narrows, the measures are concealed by an overburden of clay.

From Maciver point to Deadman point the deposits are not considered—at present—to be of any commercial value. This is also true of the greater part of the Washabuck river. East of Boulaceet harbour, although no exposures are seen, yet the indications on the surface are rather encouraging, and further investigation may develop a property of considerable commercial value.

At Lieutenant pond, and at Iona, exposures are seen near the sea-shore of sufficient area to make them of considerable value.

The greater part of the rock is a soft, white, compact variety, with smaller quantities of granular texture; also some grey and blue rocks are perceptible. Anhydrite also occurs with some prominence. The following analyses show the results of samples from this rock.

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 33·20 | 40·16 |
| Sulphuric anhydride | 45·60 | 55·60 |
| Water, loss on ignition | 21·06 | 4·52 |
| Insoluble mineral matter | 0·15 | 0·13 |
| | 100·01 | 100·41 |

No. 8.—Nyanza, Victoria county, N.S.:—

This section, together with Middle river and Baddeck river, comprises a total gypsiferous area of 14·60 square miles. With the exception of three points, the whole is devoid of outcrops, and has an overburden of clay of varying thickness. They all have an outport at Indian bay—a tributary of St. Patrick channel.

At the rear of Alex. McGregor's house a small, white, granular rock is outcropping, having a face from 10 to 20 feet, with an elevation of 60 feet above sea-level.

On James McGregor's farm, near the Baddeck river, another outcrop of a few acres occurs; but so near the sea-level that little commercial value can be attached to it, beyond its use for local purposes.

Analyses of this rock show the following composition:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 32·99 | 33·17 |
| Sulphuric anhydride | 46·60 | 46·28 |
| Water, loss on ignition | 20·88 | 20·96 |
| Insoluble mineral matter | .... | .... |
| | 100·47 | 100·41 |

No. 9.—Port Bevis or Big harbour, Victoria county, N.S.:—

From Baddeck bay on the west to St. Ann bay on the east may be considered as one continuous gypsiferous bed having an area of 15·83 square miles.

It contains many important outcrops of gypsum and anhydrite, but the latter in greater prominence.

On the shores of the Great Bras d'Or, west of Port Bevis, cliffs or solid walls of anhydrite, 10 to 50 feet in height and nearly one mile long, may be seen at different points. These are often capped with from a few inches to a few feet of gypsum, due, without doubt, to the absorption of moisture from the atmosphere.

The most important gypsum outcrops found in this area are at the head of Baddeck bay—about one mile from deep water shipping; at the rear of Margaret McKenzie's grant—about one mile from McDonald point; on the farm of Alex. McKenzie (near his house) at Plaster mines; three miles from South Gut and at North Gut. Some of these show a little anhydrite, but gypsum of a good, white, compact variety has prominence. The softer variety apparently occurs farther inland than the harder quality, and may be due to disturbance and metamorphic action.

At Port Bevis, a few years ago the Victoria Gypsum Company carried on extensive operations, but owing to increasing occurrence of anhydrite, at depth, the place was abandoned.

The following analyses will show the composition as a fair average from this section:—

| | I | II | III | IV |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime | 32·80 | 33·77 | 38·10 | 33·60 |
| Sulphuric anhydride | 46·08 | 44·63 | 53·16 | 45·45 |
| Water, loss on ignition | 21·07 | 21·05 | 8·72 | 20·70 |
| Insoluble mineral matter | 0·18 | 0·27 | 0·26 | 0·20 |
| | 100·13 | 99·72 | 100·24 | 99·95 |

No. I.—Sample from rear of Alex. McKenzie's house.

No. II.—Sample from the Margaret McKenzie grant.

No. III.—Sample from a face 70 feet high and 650 feet long east of Alex. McKenzie's house.

No. IV.—Sample from near South Gut.

No. 10.—Boularderie island, Victoria county, N.S.:—

On the south side of Boularderie island there is a small area of 282 acres, known as Island point. It is about two miles long, projecting into St. Andrew channel, and is practically made up of gypsum outcrops, with some small patches of carbonate of lime.

The rock in the most part is white in colour, some little grey intermixed; all a compact soft variety.

The following analyses show the comparison:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent |
| Lime | 32·24 | 33·33 |
| Sulphuric anhydride | 46·08 | 45·93 |
| Water, loss on ignition | 20·85 | 20·82 |
| Insoluble mineral matter | 0·50 | .... |
| | 99·07 | 100·08 |

No. 11.—Goose cove, St. Ann bay, Victoria county, N.S.:—

Here, and at Oregon, four and a half miles from the mouth of North river, occur small gypsiferous areas: at Oregon, 134 acres; at Goose cove, two areas having a total area of 230 acres. At the former place the measures are all concealed; at the latter large exposures from 40 to 60 feet in height are seen. One of these has been opened up and operated for several years by the Victoria Gypsum Company. It is situated three and a half miles by rail from their shipping pier at Munroe point. The rock is white, light grey, and mottled white in colour; the white having prominence. The outcrops are a soft, compact variety, and the operations here prove this to be true to a depth of 30 or 40 feet; but during the summer of 1908, while sinking on the floor of the quarry, anhydrite was discovered in considerable quantities. The following analyses show the composition:—

| | I | II | III |
|---|---|---|---|
| | Per cent. | Per cent | Per cent. |
| Lime | 42·80 | 33·20 | 32·87 |
| Ferric oxide and alumina | trace. | .... | .... |
| Sulphuric anhydride | 56·16 | 46·08 | 46·14 |
| Water, loss on ignition | 0·73 | 20·68 | 20·73 |
| Insoluble mineral matter | 0·80 | 0·30 | 0·20 |

No. I.—Sample from floor of quarry.
No. II.—Sample of mottled white.
No. III.—Average sample from stock pile.

No. 12. Ingonish, Victoria county, N.S.

On the north side of Ingonish harbour white cliffs of gypsum are seen, having an average height of 50 feet. The outcrops and gypsiferous measures have a total area of 287 acres, and extend northeasterly through the Donovan and Shea grants, to the northeast shore of South bay, where small outcrops are again seen. The rock is a very pure, compact, white variety.

Analysis:—

| | Per cent. |
|---|---|
| Lime | 33·12 |
| Sulphuric anhydride | 45·88 |
| Water, loss on ignition | 21·10 |
| Insoluble mineral matter | 0·22 |
| | 100·32 |

No. 13. Aspy bay, Victoria county, N.S.

Here, extending from the Atlantic ocean inland about six miles, in a somewhat triangular shape, is a gypsiferous area of 7·98 square miles. Although much of this area is low interval land, yet there are many large exposures of gypsum. This is particularly true on the north side of Middle pond and on Middle river, where exposures from a minimum to 70 feet in height are seen covering many acres.

At present these deposits are inaccessible for want of shipping facilities. The natural outport would be North pond at Dingwall. This has been a good harbour with abundance of water, but has been closed to navigation by the sea washing up sand and gravel from the ocean, and forming a bar across the entrance.

The rock is white, mottled white, and grey, and of compact crystallization. Some little anhydrite is seen on Middle river, and in this, cells of crude petroleum are found. The following analyses are from average samples taken from this section, and will serve to show the composition:—

| | Per cent. | Per cent. | Per cent. |
|---|---|---|---|
| Lime | 41·30 | 33·62 | 32·97 |
| Sulphuric anhydride | 57·81 | 45·28 | 46·16 |
| Water, loss on ignition | 0·82 | 21·06 | 21·00 |
| Insoluble mineral matter | 0·07 | 0·05 | 0·15 |
| Bitume | 0·08 | .... | . |
| | 100·08 | 100·01 | 100·28 |

No. 14. Bay St. Lawrence, Victoria county, N.S.

In the most northerly bay of the island of Cape Breton there occurs a small gypsiferous area with few outcrops. It is practically inaccessible as a commercial product, and could be utilized only for local purposes.

No. 15.—The above applies and is also true of a small area at Pleasant bay, Inverness county, N.S.

No. 16.—Cheticamp, Inverness county, N.S.:—

The Cheticamp gypsiferous area of 2·76 square miles is one of the most available and important deposits of the Province. It extends south from the mouth of the Cheticamp river on the north to below Friar point. The principal outcrops are in the valley of Au Coin brook and at Grand Etang, occurring in cliffs from 60 to 120 feet in height. Much of the area, however, is covered with an overburden of clay, in many places not exceeding 2 feet in thickness.

The Great Northern Mining Company has developed quarries on the Au Coin outcrops, and erected a very modern, electrically driven, plaster mill, on the interval below, one and three-quarter miles southeast of Eastern harbour, where ample shipping facilities have been acquired.

The gypsum, as developed, is made up of different beds, and has a total thickness of over 1,000 feet. The first, or lower bed, consists principally of a rock, white in colour, containing very small crystals of selenite. This is succeeded by a very heavy bed of snowy white, compact gypsum, mottled and banded with a dark bituminous material. The next in order is a thick bed of hydraulic limestone. Above this is a vast bed of selenitic grey and white gypsum, cut by vertical veins of pure transparent selenite running parallel to the strike, with veinlets or stringers cutting off horizontally. One vein of selenite has a width of from 8 to 20 feet, and may be traced for at least half a mile.

The following analyses will show the quality of a portion of this deposit. Other analyses follow showing the results of careful sampling of the whole deposit:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 32·96 | 32·80 |
| Sulphuric anhydride | 46·20 | 46·32 |
| Water, loss on ignition | 0·98 | 20·92 |

No. I.—General sample across face of white quarry.
" II.—From the 8 ft. selenite vein.

No. 17.—Margaree river, Inverness county, N.S.:—

In the valley of the Margaree river occur several gypsiferous areas which will be known as: Margaree, 1·41 square miles; northeast Margaree, 8·60 square miles; southwest Margaree, 3·55 square miles; and the Ross section, 1·6 square miles.

In the Margaree area all the gypsum is concealed with an overburden of clay, except a small outcrop on the shore near the mouth of the river. The above is also true of southwest Margaree; small outcrops occurring on Allen brook, and at Upper Margaree.

In the northeast Margaree area, outcrops occur at Levis farm, Hogsback hill, and on the west side of the river. The most important of these is that at Hogsback hill, where good, white, compact gypsum outcrops in considerable prominence.

In the Ross section, the principal outcrop occurs on the west side of northeast Margaree river, near where Munro brook disappears in the Gypsum cave.

Although much of this is a very good quality, yet it is not at all probable it will ever become of great commercial value; being inaccessible to transportation facilities. It should have some value for local purposes, such as a fertilizer, as the soil of the Margaree valley is particularly adapted for its use, and would give excellent results on clover and leguminous crops.

The following are analyses taken from this territory:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 33·20 | 33.00 |
| Sulphuric anhydride | 44·68 | 45·64 |
| Water, loss on ignition | 21·04 | 20·96 |
| Insoluble mineral matter | 0·30 | 0·30 |
| | 99·22 | 99·90 |

| | III | IV | V. |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Lime | 30·80 | 32·80 | 33·20 |
| Ferric oxide and alumina | 0·60 | 0·30 | .... |
| Sulphuric anhydride | 40·80 | 45·72 | 46·32 |
| Carbonic anhydride | 1·85 | .... | .... |
| Water, loss on ignition | 19·80 | 20·62 | 20·92 |
| Insoluble mineral matter | 5·64 | 0·80 | .... |
| | 99·49 | 100·24 | 100·44 |

No. 18.—Broad Cove marsh, Inverness county, N.S.:—

In this section occur three small gypsiferous areas. The most prominent is on the sea-shore, about a quarter of a mile north of the mouth of McLeod brook; and although narrow, it extends northwardly nearly two miles. This, together with the other two lying between the road leading to southwest Margaree and the road to Inverness, make up a total area of 214 acres. They are, at present, unimportant from a commercial standpoint, being inaccessible to shipping facilities.

No. 19.—Inverness, Inverness county, N.S.:—

Here, having the advantage of the Inverness and Richmond railway and its probable extension, the deposits again become more important. At Broad Cove chapel—outcropping at the sea-shore—are extensive cliffs, consisting largely of a white, compact variety, with some little grey associated, and limestone encased in gypsum, as described on page 89. This deposit has an area of 84 acres.

In the rear of the Broad Cove Chapel area, about three-quarters of a mile back from the shore, and extending inland nearly to Loch Ban, is another area of 420 acres. This has practically no outcrops, being covered almost entirely with a heavy overburden of clay.

Two and a half miles from Inverness town, the third area in the section occurs, containing 614 acres. In this, some very prominent outcrops can be seen. Just below the big trestle, at a point known as the Laurie quarry, the outcrop has a height of 45 feet above drainage level. The rock is a white, compact variety, mixed with a dark grey, shaly variety, having rusty stains. Above this, about one mile on the McIsaac lot, an outcrop shows more even texture and colour, being principally white and compact.

The following are analyses of samples from this section:—

| | I | II | III | IV |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime.. .. .. .. .. .. .. .. .. | 32·80 | 33·00 | 34·20 | 33·00 |
| Ferric oxide and alumina.. .. | .... | .... | 0·20 | .... |
| Sulphuric anhydride .. .. .. .. .. | 46·20 | 46·56 | 46·05 | 46·60 |
| Water, loss on ignition.. .. .. | 20·92 | 20·90 | 20·60 | 20·69 |
| Insoluble mineral matter.. .... | .... | .... | .... | 0·90 |
| | 99·92 | 100·46 | 99·90 | 100·29 |

No. I.—Sample from Broad Cove chapel.
" II.—White, compact, from Laurie quarry.
" III.—Dark grey, shaly, from Laurie quarry.
" IV.—White, compact, McIsaac lot.

No. 20.—Mabou, Inverness county, N.S.:—

In this section there are numerous gypsiferous areas, which are more or less available for commercial purposes. They comprise a total area of 6·55 square miles.

At Finlay point, on the sea coast, and about one mile north of Mabou coal mines, occur cliffs of excellent, white, compact gypsum, from 35 to 50 feet in height. This area extends along and borders the sea coast for nearly three and a half miles. The exposures here are large, and every indication points to a large deposit of gypsum of a quality suitable for all ordinary manufacturing purposes; but the sea coast is rugged and very little protection could be given to shipping. To operate this deposit it would, therefore, be necessary to make the shipping point at Mabou harbour, a distance of three and a half miles, over a rather difficult pass.

At Mabou harbour the most important deposits are located, known as the Colonel Snow property, and the Beaton property.

The rock here is exposed in cliffs from 45 to 60 feet high, and consists almost wholly of a white, compact gypsum, with smaller quantities showing microscopic crystals of selenite. Very small quantities of anhydrite may be seen at the base of the cliffs.

Following east to Hillsborough and south to southwest Mabou large gypsiferous areas occur, but consist in the greater part of concealed measures. Large outcrops occur at Hillsborough, of a very soft, grey and dark grey, granular gypsum suitable only for land plaster. At southwest Mabou the rock is similar in texture, and has associated with it fine crystals of selenite.

The following analyses of samples from these different deposits will show the composition:—

| | I | II | III |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Lime.. .. .. .. .. .. .. .. .. .. .. .. | 32·80 | 32·80 | 33·88 |
| Sulphuric anhydride .. .. .. .. .. .. .. | 45·90 | 46·20 | 44·36 |
| Water, loss on ignition.. .. .. .. .. .. | 20·85 | 20·85 | 20·87 |
| Insoluble mineral matter.. .. .. .. .. | 0·40 | 0·30 | 0·50 |
| | 99·95 | 100·15 | 99·61 |

| | IV | V | VI |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Lime.. .. .. .. .. .. .. .. .. .. .. .. .. | 32·92 | 33·40 | 33·00 |
| Sulphuric anyhydride .. .. .. .. .. .. .. | 46·24 | 46·28 | 45·61 |
| Water, loss on ignition.. .. .. .. .. .. | 20·87 | 20·45 | 21·20 |
| Magnesia.. .. .. .. .. .. .. .. .. .. .. | .. | trace | .. |
| | 100·03 | 100·13 | 99·81 |

No. I.—Sample from Hillsborough—Light grey with heavy red incrustation.
" II.— " Hillsborough—Dark grey, soft, granular.
" III.— " Beaton property—White, compact, variety.
" IV.— " Col. Snow property—White, compact, with crystals of selenite.
" V.— " Finlay point—White, compact and free from selenite.
" VI.— " Southwest Mabou—Very soft, granular, with selenite crystals.

No. 21.—Smith island and Big Bridge, Inverness county, N.S.:—

Following south from Mabou to Port Hood, and continuing south to Glencoe, many gypsiferous areas will be found. From surface indications they would not be classed at the present time as commercially important, having small individual areas of little prominence, and generally carrying a heavy burden of clay.

The total area of this group is 369 acres, and the most important of the whole is that known as Smith island, consisting of 149 acres.

This island is situated about one mile from the mainland and opposite Port Hood. Its topography is low and the exposures, which in greater part are on the exposed side of the island, are few.

No. 22.—Askilton, Inverness county, N.S.:—

In this section we have what may be known as the Hastings area of seventy-five acres at Port Hastings; the Beaver Dam Lake area of 1·6 square miles, on the border line of Inverness and Richmond counties and about four and a half miles east of Point Tupper; the Askilton area of 1·8 square miles at Askilton, three and a half miles from the Intercolonial railway, or about six miles east of Port Hastings; also a small area about one and a half miles south of Askilton on Inhabitants river, consisting of 302 acres.

The Inhabitants River area, and the Beaver Dam Lake area, have very little prominence, being situated in the low ground; the Beaver Dam lake being only traceable by the pits or kettle holes, and hummocky ground. In the banks of Inhabitants river small outcrops are seen, but both areas seem to be covered heavily with clay.

The Hastings area is small. The greater part of it seems to have been eroded by the sea, and now forms a small inlet or cove having a floor of gypsum. The greater part of what remains is in outcrops from 30 to 60 feet high, consisting of a variety of colours and texture, with considerable anhydrite.

The Askilton area is the most important from all points of view in this section. It has large outcrops, some as high as 70 feet above drainage level, and the greater part is an excellent, white, compact variety, with smaller quantities of granular.

The Strait of Canso—the natural outport for the deposit, being an open port all the year—makes this deposit desirable: especially to those who export large quantities of crude rock, since it is the nearest deposit to a winter port in the Province.

The following analyses from samples of the different deposits obtainable will serve to show the average composition of these deposits:—

| | I | II | III |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Lime | 40·48 | 33·80 | 33·20 |
| Sulphuric anhydride | 55·48 | 46·08 | 46·32 |
| Water, loss on ignition | 3·90 | 19·86 | 20·85 |
| Insoluble mineral matter | 0·44 | .... | 0·14 |
| | 100·30 | 99·74 | 100·51 |

| | IV | V |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 34·20 | 33·20 |
| Sulphuric anhydride | 45·92 | 45·84 |
| Water, loss on ignition | 20·65 | 20·60 |
| Insoluble mineral matter | .... | 0·90 |
| | 100·77 | 100·54 |

Nos. I and II.—Average samples, Hastings area.
" III and IV.—Average samples of the white compact, Askilton.
" V.—Sample of the granular Askilton area.

No. 23.—River Denys, Inverness county, N.S.:—

Practically joining the McKinnon Harbour area on the east, and the Malagawachkt on the south, is a section known as River Denys. This includes a total gypsiferous area of 5·06 square miles. The principal part of this is traceable only by surface indications. The most prominent outcrop is on the east side of River Denys, below Munroes Bridge. There, the outcrops rise above the sea-level, from 10 to 45 feet, and consist principally of grey and light grey, white and mottled white; much of it having a compact texture with large portions of granular. Dark grey carbonate of lime is also found associated.

The composition of this outcrop is seen in the following analysis:—

| | Per cent. |
|---|---|
| Lime | 33·17 |
| Sulphuric anhydride | 45·43 |
| Water, loss on ignition | 20·63 |
| Insoluble mineral matter | 0·93 |
| | 100·15 |

No. 24.—Black river, Richmond county, N.S.:—

At Black river, south side of West bay, occurs a gypsiferous area of 1·81 square miles. This is reasonably accessible to water transportation, and may be considered as a property having commercial value. The outcrops are principally on the banks of the river, about one mile and two and a half miles from its mouth. The greater part of the rock is a white, compact variety. Some small quantities are coloured with oxide of iron. The analyses of this deposit are not yet available.

No. 25.—Saunders cove, Cape Breton county, N.S.:—

On the south side of Boularderie and west of Grove point occurs a small gypsiferous area of 299 acres. The outcrops on the shore are small, and the area is traceable only by surface indications. The quality is a white, compact variety, associated with considerable quantities of carbonate of lime.

The following short description will indicate the location of the deposits examined and sampled throughout Nova Scotia, exclusive of those above described, from the island of Cape Breton.

COLCHESTER COUNTY, N.S.

No. 1. Deposits crossing the farms of Gregory Yuill, Samuel Creelman, and Constantine Wheelock on Pitch brook, near the mouth and on the north side of the Shubenacadie river. Three outcrops are first observed, about one mile back from the river, in the valley and banks of the brook.

Analyses:—

| | I | II | III | IV |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime.. .. .. .. .. .. .. .. .. | 30·80 | 32·88 | 32·20 | 33·80 |
| Sulphuric anhydride .. .. .. .. | 45·72 | 44·92 | 44·64 | 44·92 |
| Water, loss on ignition.. .. .. | 20·60 | 20·47 | 20·44 | 20·54 |
| Insoluble mineral matter.. .. .. | 1·30 | 1·70 | 2·30 | 0·80 |
| | 100·42 | 99·97 | 99·58 | 100·06 |

No. I.—Gregory Yuill—grey fibrous.
" II.—Gregory Yuill—grey massive.
" III.—Constantine Wheelock—dark grey with radiating structure.
" IV.—Samuel Creelman—light grey, massive.

No. 2. The deposit on the farm of G. W. Dart, at Green Oak, about one mile below the Midland Railway (D.A.R.) bridge.

The outcrop occurs in the bank of the Shubenacadie river, and is a dirty, dark, greyish, granular variety, suitable only for land plaster.

Analyses:—

| | I | II | III |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Lime.. .. .. .. .. .. .. .. .. .. .. .. | 33·20 | 33·20 | 4·40 |
| Ferric oxide and alumina.. .. .. .. .. | .... | 0·40 | 2·50 |
| Sulphuric anhydride .. .. .. .. .. .. .. | 47·04 | 45·28 | 4·24 |
| Water, loss on ignition.. .. .. .. .. .. | 19·22 | 20·66 | 5·01 |
| Insoluble mineral matter.. .. .. .. .. | 0·30 | 0·80 | 79·52 |
| | 99·76 | 100·34 | 95·67 |

No. I.—General samples of the rock.
" II.—Sample with dark bark-like encrustations.
" III.—Clay mixed with the gypsum.

Also at Green Oak, on the farm of Thomas Phillips, occurs a large outcropping of excellent, white, granulated and white, compact gypsum. This deposit can be considered commercially valuable, and years ago was operated on that basis.

Analyses:—

| | | |
|---|---|---|
| | Per cent. | Per cent. |
| Lime.. .. .. .. .. .. .. .. .. .. .. .. .. .. | 32·80 | 32·92 |
| Ferric oxide and alumina.. .. .. .. .. .. .. | .... | 0·40 |
| Sulphuric anhydride .. .. .. .. .. .. .. .. .. | 46·16 | 45·16 |
| Water, loss on ignition.. .. .. .. .. .. .. .. | 20·94 | 21·00 |
| | 99·90 | 99·48 |

No. I.—Pure white, granulated.
No. II.—Pure white, compact.

No. 3.—At Hilden, about two miles south of the Intercolonial railway, on the James Morgan estate, occur outcrops of blue, grey, and white gypsum, in exposures having an extreme height of 55 feet.

The greater part of this rock has a compact texture, but some granulated and selenitic forms are seen.

Analyses:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 33·08 | 33·00 |
| Sulphuric anhydride | 45·92 | 46·08 |
| Water, loss on ignition | 21·20 | 20·90 |
| Insoluble mineral matter | 0·10 | 0·10 |
| | 100·30 | 100·08 |

No. 4.—On the farm of John Irwin and the adjoining properties, situated at Irwin lake, three and a half miles east from the tidal waters of Cobequid bay, occur outcrops of gypsum of more or less prominence. The greater part of this gypsiferous area consists of concealed measures. The outcrops are in the most part a white granular variety.

Analyses:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 32·60 | 34·00 |
| Ferric oxide and alumina | 0·20 | 1·08 |
| Sulphuric anhydride | 45·88 | 45·72 |
| Water, loss on ignition | 21·00 | 17·77 |
| Insoluble mineral matter | 0·50 | 0·40 |
| | 100·18 | 99·97 |

No. I.—White granular.
" II.—White streaked with red and showing excess of carbonate of lime.

No. 5. About one mile nearer the tide waters of Cobequid bay, on Beaver brook, occur numerous outcrops of white, compact gypsum; but in the greater number of exposures anhydrite is found closely associated. On the farm of Isaac Sanderson this is particularly well demonstrated.

Analyses:—

| | I | II | III |
|---|---|---|---|
| | Per cent. | Per cent. | Per cent. |
| Lime | 36·80 | 33·20 | 33·72 |
| Ferric oxide and alumina | 0·40 | .... | .... |
| Sulphuric anhydride | 51·44 | 46·40 | 46·00 |
| Water, loss on ignition | 11·73 | 20·79 | 20·94 |
| Insoluble mineral matter | .... | .... | 0·35 |
| | 99·87 | 100·39 | 100·01 |

No. I.—The interior of a boulder of anhydrite which has been exposed for about 25 years.
" II.—An outside coating about 4″ thick taken from No. 1.
" III.—White compact variety occurring in same deposit.

No. 6. In Pleasant Valley, two miles south of Brookfield station on the Intercolonial railway, and five miles north of the Shubenacadie river, occur outcrops of dark, grey gypsum, showing the following analyses from average samples:—

| | Per cent. |
|---|---|
| Lime | 33·00 |
| Sulphuric anhydride | 45·76 |
| Water, loss on ignition | 20·78 |
| Insoluble mineral matter | 0·90 |
| | 100·44 |

No. 7. From two to five miles north of Brookfield station, on the Intercolonial railway, occurs a large gypsiferous area, having numerous outcrops. The principal outcrops are to be seen on the banks of the Little river running through the farms of Leonard Carter, James Lockhart, John McCulloch, J. J. Snook, Alonzo Lockhart, and on the property of Robert E. Benjamin.

Analyses:—

| | I | II | III | IV |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime | 38·20 | 39·88 | 33·00 | 33·00 |
| Manganese | 1·06 | .. | .. | .. |
| Sulphuric anhydride | 53·80 | 51·28 | 46·20 | 45·72 |
| Carbonic anhydride | 1·17 | 1·81 | .. | .. |
| Water, loss on ignition | 5·16 | 7·16 | 20·85 | 20·92 |
| Insoluble mineral matter | 0·10 | .. | .. | .. |
| | 99·49 | 100·13 | 100·05 | 99·64 |

| | V | VI | VII | VIII |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime | 33·80 | 31·28 | 31·60 | 32·88 |
| Ferric oxide and alumina | 0·56 | 1·80 | 1·00 | .. |
| Sulphuric anhydride | 42·04 | 42·44 | 42·64 | 45·52 |
| Carbonic anhydride | 3·44 | trace | .. | .. |
| Water, loss on ignition | 19·32 | 19·63 | 20·29 | 20·82 |
| Insoluble mineral matter | 0·80 | 4·20 | 4·00 | 0·40 |
| | 99·96 | 99·35 | 99·53 | 99·62 |

No. I.—Leonard Carter—anhydrite occurring in close contact with carbonate of lime.
" II.—Leonard Carter—a mixture of light grey and white.
" III.—James Lockhart—white, compact.
" IV.—John McCulloch—white, compact.
" V.—Robt. E. Benjamin—white and greyish white.
" VI.—J. J. Snook—a red pinkish mixture associated with marl.
" VII.—Robt. E. Benjamin—black, compact, somewhat columnar in structure.
" VIII.—Alonzo Lockhart—soft, white granular.

No. 8.—At Debert on the Lynds farm occurs a small deposit, unimportant for commercial purposes, but of geological interest, and well adapted to local uses as a fertilizer.

Analyses:—

| | I | II |
|---|---|---|
| | Per cent. | Per cent. |
| Lime | 32·00 | 39·20 |
| Manganese | .. | 0·12 |
| Ferric oxide and alumina | 0·48 | .. |
| Sulphuric anhydride | 41·80 | 17·24 |
| Carbonic anhydrite | .. | 21·45 |
| Water, loss on ignition | 20·91 | (1·99) |
| Insoluble mineral matter | 4·40 | 20·00 |
| | 99·59 | 100·00 |

No. I.—A greyish white, showing crystals of selenite.
" II.—Sample of dark siliceous carbonate of lime intermixed throughout the whole mass.

No. 9. East mountain—on the farms of Geo. Thompson, Samuel Roode, and Elisha Archibald, occur small isolated deposits of gypsum.

The Geo. Thompson property—about two and a half miles north of the Intercolonial railway—shows some very excellent white, compact gypsum, but the greater part of the exposure occurs as anhydrite.

Samuel Roode deposit—about two miles west of the above, and one and three-quarter miles from the railway—is a dark grey, granular variety. Operations have been carried on here in a small way and the product prepared and used as fertilizer.

Elisha Archibald deposit—situated about two and a half miles east of Thompson's, and one and a quarter miles north of the railway from Union station. This deposit shows in its outcrops an excellent quality of white, compact gypsum, with no anhydrite exposed.

Analyses:—

| | I | II | III | IV |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Lime | 33·12 | 41·20 | 32·80 | 33·20 |
| Manganese | .. | .. | .. | 0·15 |
| Sulphuric anhydride | 46·68 | 58·36 | 45·92 | 45·44 |
| Carbonic anhydride | .. | .. | .. | 0·17 |
| Water, loss on ignition | 20·68 | .. | 20·04 | 20·55 |
| Insoluble mineral matter | .. | 0·28 | 0·92 | .. |
| | 100·43 | 99·84 | 99·68 | 99·51 |

No. I.—Geo. Thompson—associated with large quantities of pure white anhydrite.
" II.—Geo. Thompson—pure white anhydrite, associated with No. I.
" III.—E. Archibald—white compact.
" IV.—Samuel Roode—greyish white.

### HANTS COUNTY, N.S.

The following deposits in Hants county have been examined and sampled, but the analyses are not yet available.

The property of the Newport Plaster and Cement Company, consisting of an area of about 4,000 acres. Here, the principal operations are carried on at Avondale, where they have shipping piers on the Avon river.

The Miller Creek property, situated near the Dominion Atlantic railway (Midland branch), and about five miles from Windsor.

The Chambers property at Meander, Brooklyn, and River Hebert.

The Mount Denson property on the southwest side of the Avon river.

The upper and lower Falmouth deposits, opposite Windsor.

The Wentworth Gypsum Company (1,200 acres), at Wentworth and Newport.

The Phillips property, situated east of the Wentworth Company's property and having the St. Croix river as its eastern boundary.

The Windsor gypsum property at Newport.

The Nova Scotia gypsum property at Threemile Plains.

CUMBERLAND COUNTY, N.S.

The Lockhart and King properties, at Hansford.

The deposits on Pugwash river and Philip river.

The Fowler quarry, at Amherst point.

The Newcombe property and the Maritime Gypsum Company's property at Nappan; and the Swan Creek deposit near Parrsboro.

In the Province of New Brunswick the following extensive deposits have been examined and sampled:—

At Hillsborough—the properties of the Albert Manufacturing Company and the J. B. King Company.

The Petitcodiac deposits—the Sussex and Upham deposits, and the deposit at Plaster Rock, on the Tobique river.

On the Magdalen islands, Que.—Deposits on Grindstone, Alright island, and Amherst island.

The analyses of these, with full descriptions of each deposit, and approximate areas and quantities available, together with cost of production and manufacturing, will appear in the final report. This general report will also contain plans and specifications of modern mills for the manufacturing of gypsum products, with tentative costs of construction and operations.

# ON FURTHER INVESTIGATION OF THE ASBESTOS DEPOSITS IN THE PROVINCE OF QUEBEC.

*Fritz Cirkel, M.E.*

Having examined all the producing asbestos mines, as well as asbestos occurrences not yet developed in the Eastern Townships of the Province of Quebec; and having also delimited the Broughton serpentine belt as set forth in my preliminary report for 1908, I devoted my time during the winter season 1908-9 to writing my report thereon and to plotting the survey over the Broughton serpentine range, which has now become a factor in the production of asbestos in that region. However, it was found that while the field work was in progress, additional important discoveries had been made in the direction of the serpentine belt in the township of Thetford; and for this reason it was deemed advisable to continue the field work during the summer season of 1909, with a view to determining the exact position of the continuation of that serpentine range in the township of Thetford, and its connexion with the extensive productive belt of Thetford-Black lake. Consequent upon a little flurry and excitement in the region, caused through the formation of additional asbestos companies—a thing of rare occurrence up to that time in the region—the prospector showed great activity, and while a great number of so-called discoveries were made, it was found that after thorough investigation these alleged new asbestos locations were in the majority of cases nothing else than huge boulders, buried deep in the overburden. All these finds gave rise at the begining to the supposition that the serpentine range, especially in the township of Thetford, was of considerable extent, especially as far as its width is concerned; and the belief was expressed that a great many productive mines might be added in the near future to those already in existence. My investigations, however, point to the fact that, excepting the long established mines in the southwesterly part of the township, this alleged productive serpentine belt is in reality of very limited dimensions, and is to be found only on ranges V and IV of that township. All the discoveries made outside this range amount to nothing. The writer lays special emphasis on this point; because operators and prospectors have spent much time and money in the development of many of these new finds, and not in one case were the deposits of sufficient extent and quality to warrant exploitation.

In addition to the serpentine range in Thetford, the big productive belt in which all the great Thetford and Black Lake mines are located was delimited. This piece of work was far more difficult to accomplish than was at first supposed; due primarily to the inaccessibility of a great part of the country, and also to the heavy humus and forest growth which covers the formation in different parts, which hides from view the different rock formations. This refers specially to the northwesterly boundaries of the range in the townships of Ireland and Wolfestown. In these cases the boundaries were laid down, based on conjectured evidence; but it is believed future exploration work will demonstrate that the contact lines of the formation will be found to be approximately correct.

As to the asbestos industry as a whole, I have dwelt upon its expansion and progress at some length in my preliminary report for 1907-8, and can only add that, the predictions as laid down in that report are, indeed, far surpassed by actual facts.

Since September 1, 1908, not less than five new asbestos mines have been added to the list, on all of which large milling plants are being erected at the present time. The total additional milling capacity of all these new establishments will be twenty-

six cyclones. Figuring on a total tonnage of 120 tons per day per cyclone, and an extraction of 6 per cent of the mill rock, this means an increase in the production of asbestos per day of 189·20 tons of mill fibre.

It is, of course, possible that if all these new mines put their product on the market simultaneously, overproduction will for some time follow; the writer is of opinion, however, that no fear need be entertained regarding the commercial disposal of such a large additional output; for the exigencies and demands of the market have, so far, kept pace with the increasing yearly output, hence it is confidently expected that in view of the ever increasing demand for asbestos slate—which consumes most of the mill fibre—no serious results need be anticipated.

# INVESTIGATION OF REPORTED IRON ORE OCCURRENCES IN THE PROVINCES OF ONTARIO, QUEBEC, AND NEW BRUNSWICK.

*B. F. Haanel, B.Sc.*

I beg to transmit, herewith, a preliminary report of my work during the summer of 1909.

This season I was instructed to examine as many iron ore mines and prospects along, and in the vicinity of the Central Ontario railway, as the time permitted; with a view to examination by means of magnetometric survey of those deposits the importance of which would justify further work. I had received instructions to this effect two years ago, but, owing to work of more immediate importance, it was impossible to begin the examination at that time. This investigation was, therefore, begun by Mr. Fréchette, who examined and made magnetometric surveys of some of the most important iron mines and prospects in the vicinity of Bessemer, Ont.

Owing, however, to some important examinations, which I was instructed to make in other parts of Ontario and Quebec, this work was again delayed to such an extent that it was possible to devote only a short time this season to the work outlined above.

The following occurrences of iron ore were examined during the summer. An occurrence of magnetic iron ore on lot 20, con. XI, and lot 7b, range V, county of Wolfe; and lots 1 and 3, range X, county of Megantic; also occurrences of chrome iron ore, near both these places; and an occurrence of magnetic iron ore near Namegos station, on the Canadian Pacific railway. Two iron properties, namely, the Chaffey and Matthews iron mines, near Newboro on the Rideau lake, were examined, and a preliminary magnetic survey made of the Matthews iron mine. Those examined along the Central Ontario railway were: Coehill iron mine; Jenkins iron mine; and occurrences of iron ore on lot 22, con. IX, township of Wollaston, county of Hastings, all in the vicinity of Coehill village; and an occurrence of iron ore near Gilmour, and two in the vicinity of Bancroft. In addition to the work just enumerated, an investigation of the northeastern corner of Northumberland county was made, where, according to reports, heavy magnetic attractions were observed, which, it was believed, pointed to the existence of an ore body. Observations were also made in the vicinity of Kingston, Ont., where, according to the magnetic survey of Kingston harbour made in the year 1863, we were led to believe iron ore might exist. An examination was also made of an occurrence of iron ore near Gaspereau station, N.B., with a view to locating positions for diamond drilling.

The summer work was somewhat broken by travelling from one region to another, and by the necessity for my presence in Ottawa in connexion with the fuel testing station.

## OCCURRENCE OF MAGNETITE AND CHROME IRON ORE IN THE COUNTIES OF WOLFE AND MEGANTIC, QUE.

In view of the construction of the proposed Quebec Eastern railway, the assistance of the Mines Branch was sought for the purpose of examining the ore occurrences along, and in the vicinity of, the projected route of the railway. In accordance with instructions, my work was confined to the examination of occurrences of iron ore in the counties of Wolfe and Megantic.

In the county of Wolfe, on lot 20, con. XI, near the northwestern shore of Lake Nicolet, the existence of a deposit of magnetite of considerable size was reported.

This occurrence was reputed to form part of an iron range extending for over a mile, and hope was entertained that it would prove, upon examination, to be a large deposit.

The ore is a magnetite, high in titanic acid, and carries about two per cent $Cr_2O_3$, and a trace of copper. Associated with the ore, in places, are calcite, and crystals of ilmenite.

The deposit occurs in serpentine, and consists of two outcrops, lying about 30 feet apart. The combined dimensions of the two outcrops are about 30 feet in length by 15 feet in width. On the largest outcrop a pit was sunk, from which some ore was raised. Some of this ore lies on the surface, adjacent to the pit. At the time of my visit the pit was full of water, which prevented an examination of the walls and bottom.

To determine the extent of this deposit, observations with the magnetometer were made over a considerable area of the surrounding neighbourhood; but the field proved to be normal, except within the immediate vicinity of the outcrop—even here the attraction was very feeble.

The deposit may be described as a pocket of a titaniferous ore, of no economic value.

The following is an analysis of a sample of ore taken from the pit:—

| | Per cent. |
|---|---|
| Metallic iron | 46·50 |
| $TiO_2$ | 26·50 |
| $Cr_2O_3$ | 1·70 |
| Cu | trace. |

Near the northern shore of Lake Nicolet— a short distance from the main road—a small pocket of chrome iron ore occurs. This, however, as well as an occurrence near the southeast side of the lake, cannot be said to be of any importance until development work is done.

In 1905 a magnetic survey was made of lot 7a, range V, township of Leeds, Province of Quebec: where a body of magnetite of considerable size was said to exist. Here, the ore occurs in pockets, only one of which is of sufficient size to attract attention. This ore formation continues in the next lot, 7b, range V, and it was to this lot and lots 1 and 3, range X, that I was instructed to confine my examination.

The rock and ore formation here are identical with that of lot 7a, range V. The ore occurs in a schistose rock and serpentine. The strike is very nearly NE-SW, with a dip to the northwest of about 45°. The ore occurs in small pockets of no economic value, and in some cases on this lot and on lots 1 and 3, range X, the magnetic indications are produced by buried boulders.

The iron ore in the vicinity of Kinnear Mills is not of sufficient quantity to warrant the construction of a railway through this part of the county of Megantic.

On the southern extremity of lot 7a, range V, township of Leeds, two pockets of exceptionally pure chrome iron ore were discovered and worked some years ago. In all, about 60 tons of ore were raised, and sold, it is said, to the Carnegie Steel Company, Philadelphia, at $25 per ton. When these pockets were exhausted, the workings were abandoned. It is, however, highly probable that systematic prospecting, if carried on, will disclose similar pockets, since the rocks in the neighbourhood of the original pockets carry considerable chromite.

### OCCURRENCE OF MAGNETITE NEAR NAMEGOS ON THE MAIN LINE OF THE CANADIAN PACIFIC RAILWAY.

Information having been sent to the Mines Branch concerning a deposit of magnetic ore near Namegos—a station on the Canadian Pacific railway—which was said to be of large dimensions, and the ore of good quality, it was deemed expedient to send

a technical officer to make an examination. I was, therefore, instructed to make this investigation.

This occurrence is confined to lots W. D. 275 and 276, of 160 acres each, situated about seven miles in an easterly direction from Namegos station. To reach this property it is advisable to go by canoe up a small creek, as the tramp through the bush is difficult, owing to fallen timber and thick underbrush.

Very little of the main rock formation is exposed on this property, the principal exposures occurring on the summit of the highest hill. Here, two parallel ridges, separated by 150 feet, are exposed for a short distance. The rock is granitic and very coarse-grained. On a fresh fracture, large crystals of hornblende, feldspar, and biotite mica can be seen. Quartz is the least abundant mineral, but can be seen with the naked eye in places. The rock is readily decomposed, and on these exposures the weathering continued to considerable depth. To the east of these exposures a ledge of nepheline rock occurs at the foot of the hill. This is also found associated with the iron ore.

My instructions were to make a detailed magnetometric survey, if the indications warranted. Such a survey would have been difficult and would have consumed much time, as the ground is not only very uneven where the ore occurs, but is heavily covered with fallen timber, which would necessitate a great deal of cutting. The indications, however, did not warrant such detailed work.

In order to test the property with a view to making a detailed survey, a baseline, bearing N 25° E (magnetic) was cut for a distance of 1,200 feet from the corner post dividing the two lots. From the northeastern extremity of this base, three lines, bearing in an easterly direction, were cut 150 feet apart. These were connected with a line run along the base of the hill, connecting two outcrops; additional readings were taken between the outcrops. Observations with the magnetometer were made along all these lines, and the trail at intervals of 30 feet. In addition, many observations were taken in other parts of the property.

The magnetic attraction was found to be pronounced only in the immediate vicinity of the outcrops; while to the north, northeast, and south of the base-line the field was normal. Since the rock associated with the iron ore was found to contain about 8 per cent Fe, it is probable that some of the feeble attractions were produced by an underlying rock impregnated with magnetite.

The outcrops appear to represent small isolated deposits, connected in some instances by a band of rock carrying some magnetite. The area of the disturbed field is about 300 feet square, but only a part of this appears mineralized with iron ore.

Two general samples of ore from the two most prominent outcrops, and one of rock carrying iron, were taken for analysis. The following is the result of the chemical examination:—

| | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| Fe. . . . . . . . . . . . . . . . . . . . . . . . . . | 63·5 | 51·81 | 8·81 |
| $TiO_2$. . . . . . . . . . . . . . . . . . . . . . . . . | 12·5 | 11·91 | 0·31 |

Sample No. 1 was taken from the most easterly outcrop; while samples Nos. 2 and 3 were taken at the foot of the hill.

From the preceding analyses of samples Nos. 1 and 2 it will be seen that the ore carries a large amount of titanic acid, rendering it of inferior quality. Sample No. 3 shows that the rock in the immediate vicinity of, and associated with the iron ore, carries about 9 per cent metallic iron, and a small amount of titanic acid. If the rock underlying the surface and connecting the outcrops carries this percentage of iron, the feeble attractions observed in certain portions of the field are readily accounted for.

The indications do not point to the existence of an ore deposit of magnitude, and hardly warrant the expenditure of much money for diamond drilling or development work.

MATTHEWS AND CHAFFEY IRON MINES, ONT.

Several reports have already been written on these mines, which were operated many years ago, but no detailed magnetic survey has ever been made. On the introduction—a few years ago—of the method of examining magnetic ore bodies by means of the magnetometer, requests were received at the Mines Branch for a technical officer to make such an examination. This summer I was instructed to examine both the Chaffey, and the Matthews iron mines, with a view—if indications warranted—to making a detailed magnetometric survey.

These mines are situated about one mile and a half from the village of Newboro. The Chaffey mine is on a small island about 500 feet square, in Mud lake, near its north shore, on lot 27, con. VI, township of South Crosby; and the Matthews mine on the main shore, about half a mile northward, on lot 1, con. VI, township of North Crosby.

As far as shipping facilities are concerned, these mines are admirably situated, having not only water communication by means of the Rideau lakes and canal to Lake Ontario, but also railway communication via the Brockville and Westport railway, which connects with the main lines.

Three large pits, with their long axis approximately parallel, constitute the main workings on the Chaffey mines. It was not possible, on account of water, to examine these workings; but the portions above water level show the pits to be separated by barren walls of rock. It is possible that these pits represent exhausted—or nearly so—ore pockets. Magnetometric observations taken at various points on the island indicate the existence of more ore; but on account of the small area apparently mineralized it was not deemed advisable to spend the time necessary to make a detailed magnetometric survey. The ore is said to contain over 9 per cent titanic acid.

At the Matthews—or Yankee mine, considerable ore was raised from a large pit about 300 feet long by 100 feet in width. It might be noted in passing that the long axis of this pit is approximately parallel to the long axis of the Chaffey pits. The pit was also full of water, thus preventing an examination of the workings. The direction of the long axis of these deposits is approximately east-northeast—west-southwest; this also represents the direction of the strike.

A preliminary magnetometric survey was made of this property, since the indications appeared more favourable. The results of the survey showed that while the ore at the old workings is very nearly exhausted, considerable ore appears to exist immediately to the south and southwest of the large pit. About 600 feet to the northwest of this pit, an area of strong vertical attraction of about 100 × 150 feet in extent, was found. This part of the property is overlaid to some depth by surface matter. The indications here, however, point to a pocket similar to those just described, and having the same general strike.

A detailed magnetometric survey of this entire property might disclose more pockets, some of which might prove of economic value. Such a detailed examination, however, was not considered practicable this summer, on account of the growing crops which it would have been necessary to tramp over, and the impossibility of obtaining efficient help in this locality during the summer months; owing to the great demand for guides by summer tourists.

The content of titanic acid in this ore is—according to an analysis made some years ago—12·32 per cent: and the ore, in addition to this, carries considerable sulphur: which deleterious ingredients together, render it an inferior ore for reduction in the furnace, except by electric smelting.

COEHILL IRON MINE ON THE CENTRAL ONTARIO RAILWAY.

The Coehill iron mine is situated at Coehill—a small village taking its name from the mine—which is the northern terminus of one of the branches of the Central

Ontario railway. Several years ago, mining operations were vigorously prosecuted here, and several hundred thousands of tons of ore raised. Since then little or no actual work has been done.

The workings consist of three shafts and an open-cut, all of which are in a bad state of repair. The workings at the time of my visit—and for a long time past, have been full of water, thus preventing an examination. About 30,000 tons of ore are stocked near the railway track, some of which is of good quality.

To determine the extent of the ore body, and, if possible, locate new pockets, a magnetometric survey was begun. It soon became apparent, however, that any detailed work in this direction was unnecessary, as the field in the vicinity of the shaft, in the northeast part of the workings, was perfectly normal, indicating an exhaustion of the magnetic ore in this vicinity. Between this shaft and the next one, in a southwesterly direction, the field also proved to be neutral. As an outcrop of a rust coated ore was approached, near the open-cut and second shaft, the field was found disturbed. Here, over a small area, some strong positive attractions were observed. This is simply a pocket of very limited extent. From this point on, over the remainder of the field, no disturbance due to the existence of ore was encountered; except when in the immediate vicinity of the open-cut.

Magnetometric observations were taken at many points on this property, but the indications were not favourable to the existence of any quantity of magnetic ore. As far as it was possible to determine from an examination of the walls of the workings exposed above the water line, the ore here appears to be very nearly exhausted. Several diamond drill holes have been put down on this property, but the logs of these were not available.

### *Jenkins Mine.*

About 1,000 feet in a southwesterly direction from the Coehill mine, is situated the Jenkins mine, on lots 17 and 18, con. VIII. Here, a small outcrop of magnetite occurs, having a strike approximately the same as that of the Coehill mine, viz., NE-SW. The exposure has a very rusty appearance, due to the decomposition of iron pyrites, which the ore can be seen to contain.

This mine was worked some years ago by means of an open-cut, from which some ore was raised. Magnetometric observations were taken along the outcrop and in different parts of these lots, but the only pronounced attractions were found to occur in the immediate vicinity of the open-cut and outcrop. This occurrence does not, therefore, appear to be very promising.

## OCCURRENCE OF IRON ORE ON LOT 22, CON. IX, TOWNSHIP OF WOLLASTON, COUNTY OF HASTINGS.

On lot 22, con. IX, there are indications of magnetic iron ore, which many in this vicinity believe points to a deposit of large dimensions. Some years ago this property was thoroughly prospected and examined by several engineers and intending purchasers, but the results of their examination and findings have never been made public.

The property has been prospected and partially developed by three pits sunk in the vicinity of outcrops. The outcrops have a rusty appearance, due to the decomposition of iron pyrites, and appear to be of the same composition and character as that common to the many occurrences of this region.

The geological formation is very similar to that of Coehill mine only a short distance to the northeast, and the ore occurs in practically the same manner—when it is possiblie to determine this from outcrops and exposures in pits, viz., in pockets. In one pit the ore is seen to occur as a vein of no great thickness, associated with a very pure limestone, and accessory minerals.

The general strike of the formation, mineralized with iron ore, is approximately NE-SW. To the east a granitic rock is exposed in some places, and is the principal rock of the region. Limestone occurs a short distance to the west, and also occurs, as stated above, associated with the ore in one of the pits.

The deepest pit at the time of my visit was full of water, but some of the ore raised in past years could be seen on the surface adjacent to the pit. A fine specimen of magnetite was taken from the most northeasterly pit, and sent to the World's Fair in 1893. Another sample taken from the same pit was said to run high in nickel, and to carry, in addition, gold and silver. No ore of this description was to be seen at the time of my visit.

Pyrrhotite is also said to have been found in another pit on this property.

The object of my visit was, to determine the extent of this alleged deposit, with a view to making a magnetic survey if the conditions warranted.

Magnetometric observations were taken over a line in the direction of the approximate strike of the different outcrops, and in many parts of the field.

According to these observations, the disturbed field, due to the presence of magnetite, was found to be of very small extent, and to always occur in the vicinity of an outcrop. The largest and only area where the vertical attraction was at all pronounced, is roughly 100 × 50 feet. Ore does not exist here, except in pockets, some of which appear to be too small to be of economic value.

*Ricketts Iron Mine.*

Magnetic iron ore is exposed on lot 17, con. XI, township of Tudor, Hastings county, in several places. About six pits have been sunk for testing purposes. These pits were supposed to lie on the strike of the ore formation, and were believed to tap the iron ore of one continuous body. The exposures occur on the east half of the lot and lie approximately in a line bearing NE-SW. Immediately to the southeast of these exposures, a granitic rock occurs, which is the principal rock of this place. To the northwest and about 350 feet from the pits, an exposure of limestone occurs.

When the underlying rock is exposed by stripping, it is seen in places to be banded with iron ore. These bands are very narrow and much contorted. When the iron ore occurs in this manner, it appears to be too lean even for concentrating purposes.

Magnetic observations taken at regular intervals along a line approximately in the direction of the strike, and on several lines at right angles to this, showed that the ore did not occur in one continuous body, but in a number of pockets. The disturbed fields produced by the existence of the ore body, or bodies, were quite pronounced in the vicinity of the outcrops or pits which uncovered ore, but the indications, as a whole, did not point to any lateral or vertical extension. A detailed magnetometric survey might prove one or two of these pockets to be of economic value. Before deciding to expend much money either in further development or diamond drilling, it would be most desirable to have such a survey made.

This property is situated about eight miles from the Central Ontario railway, the nearest station being Gilmour.

Several other occurrences of iron ore in this region have been reported upon, but with the exception of those previously mentioned, none can be considered to be of any value until some development work is done.

OCCURRENCE OF MAGNETITE ON LOT 21, CONCESSIONS 10 AND 11, TOWNSHIP OF FARADAY, COUNTY OF HASTINGS.

On the north half of lot 21, con. X, and the south half of lot 21, con. XI, township of Faraday, two iron ore claims have been staked. On both claims there are exposures of a rust coated magnetite. The claim on the north half of lot 21, con. X, does not appear to be of economic value, and will not be described here.

That on the south half of lot 21 is of greater extent, and the development work done here in the way of trenching allowed of better examination.

The strike of this formation is about NE-SW. The country rock is granite. The ore here occurs on the top and side of a hill, and the field produced by this ore body was traced by magnetometric observations for a distance of 400 feet down the side of the hill, and for a width at right angles of about 150 feet. It is not very likely that the mineralized area extends this entire distance, but it might be conservatively put at 150 feet long by about 90 feet wide. No reasonably accurate estimate, however, regarding the dimensions of this mineralized area can be made without a detailed survey, since the only exposure is on the top of the hill, and the trenching was not carried far enough to help much in this direction. A magnetometric survey made of this half of lot 21 might show the mineralized area to be large enough to prove of economic importance. This property is situated about seven miles from Bancroft and the Central Ontario railway.

### *Blairton Iron Mine.*

Some time ago, a request asking for a magnetometric survey of Blairton iron mine was received at the Mines Branch, and since I was only a short distance from this place, while investigating the magnetic disturbances reported in the northeastern corner of Northumberland county, I took advantage of the proximity of Blairton to examine the property, with a view to making a detailed magnetic survey.

The Blairton iron mine is situated on lot 8, concession I, of Belmont, county of Peterborough, and was worked quite extensively some years ago. Since that time little or no actual work has been done.

The only workings—one a deep excavation about 250 feet long × 150 feet wide, and a smaller one a short distance south of the large one—were full of water; making an examination impossible.

The geological formation of this deposit is fully described in Sir William Logan's 'Geology of Canada,' page 676, and in the Report of the Royal Commission of Ontario, pages 127-130, and need not be repeated here.

Considerable prospecting has been done, and several test pits put down. Ore has been exposed in several of these pits, and the observations taken at many stations with the magnetometer point to the existence of considerably more ore.

The ore in the vicinity of the most southern pit seems to be very nearly exhausted, as the magnetic field in its vicinity is normal.

A detailed magnetometric survey was not made, as the ground is so broken by pits and excavations from which ore has been raised, that the magnetic field has become distorted.

### OCCURRENCE OF MAGNETITE NEAR ST. JOHN, N.B.

On account of a discovery of an alleged deposit of iron ore, about eight miles from Gaspereau station on the Canadian Pacific railway, the assistance of the Mines Branch was sought for the purpose of locating positions for diamond drill holes. The intention was, to begin diamond drilling some time next winter, to prove the property.

The mineral rights covering 10,000 acres were granted to the discoverers of this occurrence.

The iron ore occurs in a quartz porphyry and consists of an exposure of hematite and magnetite in narrow veins. Neither of the veins is of economic value, and the parties interested were advised to discontinue further development work, either in the way of testing pits or diamond drilling.

CONCLUSIONS.

The theory advanced by some geologists—who examined, some time ago, the region embracing the iron ore deposits along, and in the vicinity of the Central Ontario railway—that the deposits of iron ore were igneous dikes and veins accompanying the igneous rocks, and that therefore, they were of deep rooted origin, and could consequently be worked in depth, is not of much importance to-day, since the theories on the genesis of ore deposits have been greatly altered, and, in some cases, wholly changed since that time.

The magnetic indications of those so far examined do not point to any considerable extension in depth. On some of these properties, which have been vigorously worked in past years, diamond drilling has been done, but in no case were the cores available. Had the cores been available for examination much light would have been thrown on the character of these deposits, which would be of great assistance in forming an opinion on similar occurrences.

The following are a few of the most promising deposits visited, and which the writer recommends as warranting further examination by means of a detailed magnetometric survey:—

The Matthews iron mine, lot 1, con. VI, township of North Crosby; Ricketts iron mine, on lot 17, con. XI, township of Tudor, Hastings county; and occurrence of iron ore on the south half of lot 21, con. XI, township of Faraday.

## INVESTIGATION OF THE HARRIS PEAT GAS PROCESS.

The Harris gas process for generating gas from waste products, such as city garbage, manure, sawdust, and peat, has been more or less advertised by circulars setting forth the claims of the inventor. Recently, the attention of the Mines Branch was directed to this process by a Canadian business man, who for some years has been interested in peat, and who believed that much industrial benefit would be derived in Canada from the introduction of this process if the many claims set forth in the descriptive circulars could be substantiated.

After looking over the patent specifications and a description of the process, as set forth in the descriptive circulars above mentioned, it was at first decided that the process did not warrant an investigation by a technical officer of the Mines Branch; inasmuch as the principles involved precluded the possibility of generating gas from any of the above substances efficiently or economically. Since, however, the idea prevailed among a few interested in peat that the process was both economical and efficient, it was later deemed advisable in the interests of the peat industry of Canada, to make a detailed investigation of it, and if the process were found to be impracticable to publish the results with a view to preventing an addition to the long list of failures and consequent loss of money, which have resulted from the many impractical exploitations of peat bogs in Canada.

One of the most important claims made by the inventor for his process is that peat containing upwards of 75 per cent moisture can be treated in an ordinary gas retort, with an output of gas largely exceeding that made by the ordinary process from coal, and of a higher calorific value than that of coal illuminating gas.

The object, therefore, of the investigation was to test the process as thoroughly as possible, in order either to verify, or to disprove this and other claims as set forth by the inventor. No attempt will be made to discuss the commercial aspect of the process under any other conditions than those existing when the test was made. Unfortunately, the retort was not designed to allow of its being heated by the gas generated.

The demonstration plant, placed at our disposal by Mr. L. J. Harris, consisted of an ordinary single bench gas retort, which was heated by coke, with condensers, purifiers, etc., similar to those employed in the ordinary method of making illuminating gas from coal. The capacity of the gasometer was about 100 cubic feet, which necessitated the retorting of small charges of peat, viz., 20 pounds; since all measurements from the volume of gas produced were made with it, the weight of the charge had to be so taken that the gas evolved, after complete retorting, did not exceed the capacity of the gasometer.

DESCRIPTION OF PROCESS.

The process consists in the treatment of raw peat, containing upwards of 75 per cent of moisture, with a mixture composed of 40 gallons crude oil; 4 pounds ferrous sulphate; 4 pounds caustic potash; 4 pounds caustic lime, and sufficient flour and water to emulsify the mixture. Ten gallons of the mixture, according to Mr. Harris' patent specifications, or 12 gallons, as recommended by him personally (the latter quantity was used by us) is sprinkled or sprayed on a ton of the raw peat, which is then ready for retorting.

The peat bog at Alfred, owned by the Government, was frozen at the time of this investigation, hence it was impossible to send our own peat for the test, as was originally planned. The peat used was that obtained by Mr. Harris from a bog near Newark, N.J. It was fibrous, and contained petroleum. This latter was shown on the analysis of a sample taken for examination in our laboratory.

All gas analyses and determinations of the calorific value per cubic foot were made at the plant in Newark. An Elliot apparatus was employed for making the gas analyses, and the Junker's calorimeter for the determination of the heating value.

The analyses of the samples of peat; the retort residue; the oil extraction, and the determination of the calorific value of the peat and oil used were made in the laboratory of the Mines Branch. All samples for analysis were taken by Mr. M. F. Connor, Assistant Chemist to the Mines Branch, who made all the gas analyses at Newark, and later, the remainder of the determinations in Ottawa.

### *The Test.*

The duration of the test was 8 hours and 5 minutes: during which time 80 pounds of raw peat, treated with oil and chemicals, according to the patent specifications, were retorted. Measurements were made of the quantities of gas produced and of coke consumed for heating the retort. Samples of the gas produced; of the cinders after retorting, of the oil used; and the peat before and after treatment with the mixture of oil and chemicals, were taken for analysis.

### *The Inventor's Claims.*

(1) That peat containing upwards of 75 per cent moisture, rendering it unfit for other purposes on account of the large amount of heat necessary to evaporate the moisture can be utilized by means of this process, yielding a superior gas for light, heat, and power.

(2) That one ton of peat containing upwards of 75 per cent moisture, when treated according to this process, will produce 12,000 to 14,000 cubic feet of gas, and will have a candle power nearly double, and a calorific value of one-third to one-half more than that of city gas.

(3 That by means of this process a charge of waste material, such as peat, can be retorted in less than half the time required to retort a similar quantity of coal—thereby saving enormously in time, fuel, and labour, as well as tremendously increasing the output.

(4) That the heating of the retorts to generate the gas can be accomplished by the consumption of not more than one-third the amount of the gas produced in the retorts themselves—once the operation is started.

(5) That a plant has been erected at No. 197 Vandepool street, Newark, N.J., which is in operation, proving the great commercial value of the Harris process, where all the above-mentioned claims can be readily substantiated.

(The other claims made by the inventor do not need consideration here.)

## RESULTS OF THE TEST.

### *Analysis of the Gas.*

Four samples of gas were collected for analysis from the last four runs; but since all the analyses agree more or less closely, only the analysis of the sample collected during the last run will be given. It should be mentioned here, that five runs were made: the first two consisting of 10 pound charges of peat, and the last three of 20 pound charges.

The analysis of the gas produced is as follows:—

| | Per cent. |
|---|---|
| Heavy hydrocarbon vapours | 5·00 |
| Illuminants | 8·70 |
| Oxygen | 0·80 |
| Carbonic oxide | 8·00 |
| Carbon dioxide | 5·00 |
| Marsh gas ($CH_4$) | 19·00 |
| Hydrogen | 40·84 |
| Nitrogen | 12·66 |
| | 100·00 |

The calorific value of the gas calculated from the above analysis is 669 B. T. U. per cubic foot; and that determined by Junker's calorimeter 675 B. T. U. per cubic foot, which is a very close check. This is, however, high, and the average calorific value of all the runs, viz., 640, will be used in the calculations.

A proximate analysis of the retort residue gives the following quantities:—

| | Per cent. |
|---|---|
| Volatile matter | 26·60 |
| Fixed carbon | 48·00 |
| Ash | 25·40 |

The residue, although containing a large amount of combustible material, was in such a finely divided condition when withdrawn from the retort, that it could not be put to any commercial use; such, for instance, as the coke resulting from the gasification of coal when manufacturing town gas.

The percentage of ash in the peat treated with oil and chemicals was 2 per cent.

### *Oil Extraction.*

As mentioned above, the peat before treatment with the oil and chemicals was found to contain petroleum. From several analyses of the samples taken at Newark the quantity of petroleum contained was found to be 13 per cent, by weight, of the peat freed from water.

The following table of results has been calculated to show the quantity of gas, etc., that would result from the retorting of 80 pounds of peat, and that which would result, were 2,000 pounds of peat retorted:—

| Tests. | Peat actually retorted, 80 lbs. | Per ton (2,000 lbs.) of raw peat (calculated). |
|---|---|---|
| Moisture content | 75 % | 75 % |
| Dry peat substance | 20 lbs. | 500 lbs. |
| Water contained | 60 " | 1,500 " |
| Oil added with chemicals | 4·32 " | 108 " |
| Oil found in raw peat | 2·60 " | 65 " |
| Total oil in peat | 6·92 " | 173 " |
| Calorific value per lb. of dried sample of peat with oil extracted | 8,215·00 B.T.U. | 8,215·00 B.T.U. |
| Calorific value per lb. of oil used | 19,080·00 " | 19,080·00 " |
| Amount of peat coke residue | 1·50 lbs. | 37·5 " |
| Calorific value per lb. of the peat coke residues | 11,160·00 B.T.U. | 11,160·00 " |
| Cubic feet of gas produced | 346·00 | 8,650·00 |
| Calorific value of gas per cubic foot, average | 640·00 B.T.U | 640·00 B.T.U. |
| Amount of chemicals mixed with the peat | 0·15 lbs. | 3·00 lbs. |
| Coke consumed in heating retort | 200·00 " | |
| Coke consumed for retorting only | 94·00 " | 2,300·00 " |

The following calculations are made to show the distribution of heat units among the substances composing the charge to be retorted, and also the percentage of heat units supplied to the gas by the oil.

Heating value of the raw charge put into retort:—

| | | | |
|---|---|---|---|
| Peat, 20 lbs (dry substance) | 8,215 × 20 | = | 164,300 B.T.U. |
| Oil, 6·92 lbs | 19,080 × 6·9 | = | 131,658 " |
| Total | | | 295,958 " |

Heating value of gas produced and peat coke residue:—

| | | | |
|---|---|---|---|
| 346 cubic feet of gas | 346 × 640 | = | 221,440 B.T.U. |
| 1·5 lbs. peat and coke | 11,160 × 1·5 | = | 16,740 " |
| Total | | | 238,180 " |

Percentage of the total heat units of charge supplied by the oil contained $\dfrac{131,652}{295,958} = 44{\cdot}4\ \%$

Ratio of the heat units of the oil supplied to the total heat units of the gas produced $\dfrac{131,652}{221,440} = 59{\cdot}4\ \%$

The following calculation is made to show the amount of heat absorbed in raising 60 pounds of water from 62° F. to steam (212°) at atmospheric pressure. Sixty pounds of water is the actual amount which was contained in the total weight of peat retorted.

The total heat of atmospheric steam raised from one pound of water supplied at 62° F. is 1116·6 B.T.U., and, therefore, 1116·6 × 60=66996 B.T.U.: which is the amount of heat necessary to theoretically evaporate 60 pounds of water.

Since the gas produced from one gallon of oil by the Pintsch process is 90·03 cubic feet,[1] with a heating value of about 1390 B.T.U. per cubic foot, the heating value of gas produced from one gallon of oil would be:—

1390 × 90·03=125,141·7 B.T.U.

and since the total amount of oil contained in the peat retorted was 0·788 gallons, or 6·92 pounds,

125,141·7 × 0·788=98,612 B.T.U.

will represent the heat value contributed to the gas by the oil.

[1] 'Engineering Chemistry,' Stillman, p. 173.

The heat value of the gas supplied by the peat alone would then be:—

221,440—98,612 = 122,828 B.T.U.

and, after supplying the heat necessary to evaporate the water contained in the peat—which takes no part in the process other than to absorb a large amount of heat—the total heat value of the gas remaining would be:—

122,828—66,996=55,932 B.T.U.;

about 25 per cent of the heat value of the gas generated from the peat mixed with oil.

To maintain the temperature of the retort necessary for gasifying dry peat—while retorting, and when withdrawing old and introducing new charge—the remaining 55,932 B.T.U. would not be sufficient.

The above calculations are theoretical, and must not be taken as the results which might be expected in ordinary practice. In practice, the above calculated consumption of heat for evaporating the water contained in the charge and heating the retort would be far exceeded on account of the heat carried off by chimney gases, and loss of heat by radiation from the surfaces of the furnace and setting. For example, the loss of heat in chimney gases and loss from radiation in a bench of 7 retorts heated by coke, which was investigated by Euchêne, amounted to 56·5 per cent in the case of the former, and 15·3 per cent in the case of the latter; or together, about 72 per cent of the heat produced by the combustion of the coke used to heat retort.[1] In the present case this would leave about 28 per cent of 55,932 B.T.U., or 15,660 B.T.U. for heating retorts, together with their contents and products.

The amount of coke actually consumed for retorting only, which includes, of course, the heat required for evaporating the water in the peat, was 94 pounds; and assuming the heat value of the coke to be 14,000 B.T.U. per pound, the heat required for retorting the wet peat was 94 × 14,000=1,316,000 B.T.U., which exceeds by about six times the heat value of the gas produced. It may be noted that the heat value of the gas after making the above deductions, available for retorting, is only 55,932 B.T.U., which is very inconsiderable when compared with the heat units supplied by the coke.

No reference will be made here to the fuel consumed for heating the retort between charges, since the time rquired for this operation might be much shortened in ordinary practice.

Although the gas produced was of good calorific and illuminating value, it will readily be seen that, in no sense can it be described as an economic process. The peat coke produced—which would amount, per ton of wet peat retorted, to about 37·5 pounds—retains the form of peat, which, when quenched with water, falls into small particles, hence has no commercial value.

The time required to retort 80 pounds of peat, containing 75 per cent moisture, was 3 hours and 48 minutes; while that required to retort 400 pounds of coal would be about 4 hours.

Before concluding, it may be mentioned that many experiments have been made and many processes tried for generating illuminating gas from peat in European countries not so abundantly supplied with coal as the United States and Canada; but that all these processes proved uneconomic when coal was at all accessible. 'In general, however, peat will not be distilled or carbonized with obtaining gas for illuminating purposes as the primary object. But the gas which results as a secondary product when compressed and dried peat is distilled, as in Austria, for the sake of the charcoal or coke, and tarry and nitrogenous products; or when the peat is carbonized, as in Russia, for the production of coke for use as a fuel, may well be

[1]Gas Manufacture, a Practical Handbook, by W. J. A. Butterfield, M.A., F.I.C., pp. 81-82.

utilized locally for lighting by the aid of mantles.'[1] In this latter case, the gas produced is a by-product, as in the case when making blast furnace coke.

Perfectly dry compressed peat yields at a red heat 11,000 cubic feet of gas per ton, and nearly 900 pounds of coke, as well as 15 gallons of tar, and a quantity of ammoniacal liquor.[2]

### CONCLUSIONS.

(1) The water contained in the peat is not utilized in the production of gas, since it is entirely evaporated before the carbon in the peat becomes incandescent, or even red-hot, and passes off immediately into the condenser as soon as it is vaporized. The formation of water gas cannot, therefore, take place, since the water vapour can in no way come into contact with the hot carbon.

(3) One ton of peat, containing 75 per cent moisture, produced 8,650 cubic feet of gas, which had a calorific value of 640 B.T.U. per cubic foot, or about equal to that of city gas, and 37 pounds of peat coke of no commercial value.

(3) The time required to retort 80 pounds of peat was 3 hours and 48 minutes, or about equal to the time required to retort 400 pounds of coal.

(4) No arrangement existed at the plant investigated for heating the retort by the gas generated; but the gas remaining after deducting the heating value contributed by the oil is in no sense sufficient to evaporate the large amount of water, and retort the charge.

(5) The operations—mechanical and thermic—of the plant visited and tested at Newark, N.J., in no sense proved this process to be economical, or the products of commercial value, in fact, none of the claims investigated were substantiated.

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[1] Gas Manufacture, a Practical Handbook, by W. J. A. Butterfield, M.A., F.I.C., page 8.
[2] Ibid, p. 9.

# PRELIMINARY REPORT ON THE PEAT BOGS OF CANADA.

*A. Anrep.*

In accordance with instructions, I continued, during the season of 1909, a thorough investigation of peat bogs of Ontario, in order to ascertain the extent, depth, and quality of the peat contained therein.

The bogs first investigated were those for which petitions had been received, asking for examination, and others favourably located as regards transportation, and a convenient market.

As part of the season was required for the development of the Alfred peat bog, and as a systematic investigation of a peat bog occupies considerable time, only a few bogs were examined.

During the season of 1909 the following bogs—all located in the Province of Ontario—were investigated:—

(1) The Brockville peat bog, situated two and a half miles northwest of Brockville, in Leeds county.

(2) Komoka peat bog, situated in Lobo and Caradoc townships, Middlesex county.

(3) The Brunner peat bog, situated in Ellice township, Perth county.

(4) The Rondeau peat bog, situated in Harwich township, Kent county.

(5) Part of Alfred peat bog—the Government property—300 acres, more or less, in Alfred township, Prescott county.

Part of July, the months of August, September, and part of October were spent at Alfred, superintending the erecting of the peat plant.

The Anrep peat machine, with auxiliary conveyer and platform—which was imported from Sweden in 1908, and used for manufacturing peat fuel at Victoria Road—was moved during the past summer to Alfred, where it is now installed, together with other machinery imported recently from Sweden and Germany, making a complete plant for the manufacture of air-dried peat.

While this plant was being installed, the following work was also carried on:—

*Drainage of Alfred Peat Bog.*

| | Cubic yards. |
|---|---|
| (1) Main ditch, 3,125 feet long, 6 feet wide at the top and 2 feet at the bottom, by 9 feet deep.. .. .. .. .. .. | 4,166 |
| (2) Parallel ditch to the main, 2,800 feet long, 4 feet wide at the top, and 2 feet at the bottom, by 4 feet deep.. .. | 1,615 |
| (3) Covered in ditches, 6,000 feet long, 2 feet wide at the top, and 1′-4″ at the bottom, by 3 feet deep.. .. .. | 1,111 |
| (4) Open ditches, 3,000 feet long, 2 feet wide at the top, and 1′-4″ at the bottom, by 3 feet deep.. .. .. .. .. | 555 |
| (5) Water course ditches, 4,000 feet long, 3 feet wide at the top, and 1′-6″ at the bottom, by 4 feet deep.. .. .. | 1,333 |
| (6) Enlarging ditches, 5,000 feet long, 2 feet wide at the top, and 1 foot at the bottom, by 2 feet deep.. .. .. .. | 555 |
| Total cubic yards of drainage during months of August and September.. .. .. .. .. .. | 9,335 |

The following buildings were constructed at the Alfred peat bog:—

*Buildings.*

(1) Peat shed, for storage of dried peat, 160 feet long, 22 feet wide, and 18 feet high.

(2) Tool shed and blacksmith's shop, 22 feet long, 13 feet wide, and 7 feet high.

(3) Office, 16 feet by 16 feet by 8 feet high.

(4) Movable housing for peat machine, 22 feet long, 8 feet wide, and 10 feet high.

During September I attended the meeting of the American Peat Society, held at Boston, Mass., U.S.A. In October, I shipped from Victoria Road about 70 tons of last year's peat to the gas producer plant which is under construction at Ottawa.

Details of the investigation of the above-mentioned bogs, together with diagrams and maps, will be included in a special report, to be issued as Bulletin No. 2, entitled, 'Investigation of the Peat Bogs and Peat Fuel Industry of Canada.'

## COLLECTION OF DATA ON COAL MINING IN NOVA SCOTIA.

*Joseph G. S. Hudson.*

The greater part of 1909 was occupied in working on my report on coal mining in Nova Scotia; this report comprises 1,621 pages of manuscript, and with the numerous photos, drawings, and maps, will make a volume of considerable magnitude. The following is a short syllabus of the contents:—

Area and extent of the coal field. Early history of mining in Nova Scotia. Development and expansion of the coal trade. Coal companies, railways, and shipping piers. Descriptive articles on the works and mines of the coal companies operating in the Province of Nova Scotia. Mode and method of working coal; sections of the coal seams, together with information and data on coal cutting, haulage machinery, and general appliances. Accidents in mines; the use of safety explosives, and rescue stations. Tabulated rates of wages and employes' contracts. On screening and coal handling appliances; also on the improvement in value of secondary coals, by means of wash plants. Advisability of indirectly transforming slack coal into electric energy at the mine for transmission to manufacturing centres. The working of coal seams under submarine areas.

Immediately after submitting the above-mentioned report, I started out to procure information on the Draeger rescue apparatus for oxygen breathing in mine rescue work, and visited the central rescue station of the Dominion Coal Company, at Glace Bay, Cape Breton. While in this region I visited the coke ovens and by-product plant of the Dominion Iron and Steel Company, Sydney, with a view to obtaining data on coke making and coke oven construction. I also inspected the coke oven system of the Nova Scotia Steel and Coal Company at Sydney Mines, which is of the Bauer and Bertrand type. At Inverness, Cape Breton, I investigated the application of the longwall method to submarine coal mining in operation there, in order to supplement the data already incorporated in my report on Nova Scotia coal mining. A visit to the Pictou coal field also resulted in the collection of further data of importance.

Upon returning to Ottawa again (Nov. 1), I at once began—in accordance with your urgent instructions—to prepare and arrange in systematic form, information on explosives already collected, to enable the Department to draft a bill for regulating their manufacture and use.

A preliminary report on Accidents in Mines has been compiled and is submitted herewith. The subject of mine accidents has also been attracting a great deal of public attention in the United States, and the Government of the United States has recently employed a committee of three foreign experts from Europe, to investigate coal mine accidents, their cause and prevention. This report is of far-reaching importance; and since coal mining conditions in Canada and the United States are very similar, it has been deemed desirable to publish it as an appendix to this report.

### PRELIMINARY REPORT ON ACCIDENTS IN MINES.

In accordance with your instructions to make a formal report on Accidents in Mines and on the use of Explosives, I herewith submit the data and information which I have gathered within the short time at my disposal.

In the first place, I deem it my duty to draw your attention to the lamentable fatalities in the coal and metalliferous mines of Canada.

Mine accidents, and the fatalities due to the careless use of explosives, have attracted intense interest in the United States, leading recently to the formulation of drastic measures for the prevention thereof: the deplorable condition of affairs in Canada is so similar to that of the United States that effective measures for the prevention of the serious loss of life and limb cannot be delayed.

In Europe, where mining has been carried on for centuries, hard earned experience has led to the formulation of wise rules and regulations, with consequent decrease in loss of life.

In view, therefore, of what is being done at the present time in the United States, and what has already been done in Europe, Canada cannot afford to take any subordinate position in this matter.

## ACCIDENTS IN MINES.

In the year 1855, in the United Kingdom, a commission was appointed to investigate and report on accidents in mines and their causes, and to suggest necessary legislation for lessening the great loss of life among mine workers.

With this object in view, skilled mining engineers of known integrity were appointed as inspectors of mines: men whose training had been practical, both in regard to their knowledge of mining conditions as they actually exist, and because of their acquaintance with the men to whom the proposed laws apply.

That the laws governing the regulations of mines, both in coal and metalliferous mining, were effective is apparent from the fact that in the coal mines of Great Britain the death rate has been reduced as follows:—

| | Average 10 years. |
|---|---|
| Years 1873 to 1882, the death rate per 1,000 men employed, was | 2·24 |
| 1883 to 1892 | 1·81 |
| 1893 to 1902 | 1·39 |
| | Average. |
| 1903, 1904, 1905, 1906, 1907 | 1·29 |

| | Average 10 years. |
|---|---|
| Taking the same period for metalliferous mines, 1873 to 1882, average death rate per 1,000 men employed, was | 1·62 |
| 1883 to 1892 | 1·44 |
| 1893 to 1902 | 1·31 |
| | Average. |
| 1903, 1904, 1905, 1906, 1907 | 1·08 |

From the foregoing figures it will be seen that there has been a steady decrease in the death rate per 1,000 men employed in the mines of the United Kingdom: but the reverse is the case both in the United States and Canada.

In Bulletin No. 333 of the United States Geological Survey—issued in 1907 by the Technological Branch—which deals with coal mines accidents, their causes and prevention, it is emphatically stated that the large increase in the production of coal probably accounts for the increased death rate per 1,000 men employed; but the following table, giving the number of men killed for each 1,000 men employed, shows that the increase cannot be accounted for in that way:—

| Year. | Deaths per 1,000 men employed. |
|---|---|
| 1895 | 2·67 |
| 1896 | 2·79 |
| 1897 | 2·34 |
| 1898 | 3·59 |
| 1899 | 2·98 |
| 1900 | 3·24 |
| 1901 | 3·24 |
| 1902 | 3·49 |
| 1903 | 3·14 |
| 1904 | 3·38 |
| 1905 | 3·53 |
| 1906 | 3·40 |
| 1907 | 4·86 |

'It has already been stated that in no country in the world are the natural conditions so favourable for the safe extracting of coal as in the United States, and it has also been pointed out that in spite of this fact the number of lives lost per 1,000 men employed is far higher than in any coal-producing country in the world.

It now remains to be shown that unless energetic means are taken to counteract this prevailing tendency, not only will the death rate, in proportion to men employed, and tons produced, increase as it has done in the last few years, but it will increase at a much more rapid rate.'

Such was the condition of things in the United States in 1907, but it will be shown hereafter that energetic measures have been adopted for the prevention of mine accidents.

Upon turning to Canada for the purpose of comparison, as regards the death rate per 1,000 men employed in coal and metalliferous mines, it can be truthfully asserted that we compare most unfavourably.

British Columbia and Nova Scotia are the two Provinces in which coal and metal mining have been carried on more extensively than in any of the other provinces.

The following statement shows the death rate per 1,000 men employed in coal mines:—

*British Columbia.*

| Year. | Per 1,000 men employed. |
|---|---|
| 1899 | 2·91 |
| 1900 | 4·06 |
| 1901 | *25·67 |
| 1902 | †34·65 |
| 1903 | 9·85 |
| 1904 | 8·31 |
| 1905 | 2·72 |
| 1906 | 3·12 |
| 1907 | 5·11 |
| 1908 | 2·95 |

An average death rate for ten years of 9·21 per 1,000 men employed, as against 1·29 in the United Kingdom.

* Wellington mine disaster. † Fernie mine disaster.

*Nova Scotia.*

| Year. | Per 1,000 men employed. |
|---|---|
| 1899 | 3·39 |
| 1900 | 3·17 |
| 1901 | 1·82 |
| 1902 | 2·60 |
| 1903 | 2·88 |
| 1904 | 2·40 |
| 1905 | 1·85 |
| 1906 | 2·39 |
| 1907 | 3·05 |
| 1908 | 3·48 |

An average death rate for ten years of 2·67 per 1,000 men employed, as against 1·29 in the United Kingdom.

It is generally supposed, but without adequate foundation, that a great many more men are killed in coal mines than in metalliferous mining. This, however, is not correct, as the following statement will show; and this fact should be emphasized in view of the coming era of metalliferous mining in the Province of Ontario.

## Comparative Records.

| Death rate per 1,000 men employed. | 1906. | 1907. | 1908. |
|---|---|---|---|
| *British Columbia:—* | | | |
| Coal | 3·12 | 5·12 | 2·95 |
| Metal | 4·57 | 5·51 | 5·93 |
| *Ontario:—* | | | |
| Copper and nickel | 2·45 | 2·19 | |
| Silver and iron | 2·84 | 7·36 | |
| *Nova Scotia:—* | | | |
| Coal | 2·31 | 3·05 | 3·48 |
| Metal | 11·61 | 4·14 | |

With regard to the Province of Ontario, however, in 1908 the record for one section of the Province seems so alarming that special attention is directed thereto. In making comparisons with the statistics from other districts, however, it must be recognized that in Ontario practically every accident, excepting a few in the more remote districts where only prospecting is in progress, is recorded, but only very imperfect records of the number of men employed on the properties are obtainable. Hence it becomes difficult to reduce the accidents, fatal or otherwise, to the usual ratio per 1,000 employed.

In the report of the Bureau of Mines for 1908, Mr. E. T. Corkill, the Inspector of Mines, devotes considerable space to accidents in mines, especially in the Cobalt district. From tables published on pages 69 and 70, we learn that the number of fatal accidents in the district was thirty, twenty-seven of which took place underground. Of these twenty-seven fatalities, thirteen took place in silver producing mines[1] and fourteen in non-producing mines of the district, several of the latter being accidents in prospecting shafts.

[1] Figures supplied by T. W. Gibson, Deputy Minister of Mines.

On pages 13 and 14 of the same report it is stated that there were 1,089 underground workers and 1,325 above ground in the silver producing mines, a total of 2,414 employes. Since the provincial returns show thirteen fatalities among 1,089 employes underground, the ratio for these silver producing mines becomes 11·94 per 1,000 men employed underground. No data being available as to the number of men employed underground on those properties which are classed as non-producing, no ratio can be determined for this class of accident, but it may be assumed that the number of men employed in these properties was less than in the producing mines with a correspondingly higher ratio of fatalities. The total number of men employed in the district was between 3,500 and 4,000.

An examination of the statistics of mining accidents, in the British colonies and in foreign countries, as published in a report by the Home Office, Part IV, Colonial and Foreign Statistics, 1907, to the British government, showed no record as high as 11·94 fatal accidents per 1,000 employes.

In the Transvaal, where Kaffir labour is employed, the death rate per 1,000 men employed (in 1906) was five. This was deemed so alarming that a Royal Commission was instituted at once.

For comparative purposes, accidents are classified as shown in the following German schedule, and since Ontario is under review, it will serve a useful purpose to compare them.

### Accidents.

| Classification. | Germany 1906. | Ontario 1906. |
|---|---|---|
| | Per cent. | Per cent. |
| Accidents owing to danger inherent to the work itself | 69·31 | 44·7 |
| " due to defects in the mine workings | 00·78 | 31·9 |
| " through fault of fellow workmen | 3·24 | 8·5 |
| " through fault of injured person | 26·67 | 14·9 |

The manifest conclusions to be drawn from the above are as follows:—

(1) That the class of work is not as dangerous in Ontario as in Germany.

(2) That the management of the Ontario mines has much to answer for as regards the loss of life.

(3) That the workmen in Ontario mines will compare favourably with the German workmen.

The foregoing facts indicate a lamentable state of affairs, as regards loss of life and limb in Canadian mines; and the seriousness of the situation demands that instant action be taken to provide a remedy.

#### SUGGESTED REMEDY.

At present, provincial governments have the power to enact the laws and regulations for mines, and for the gathering of mining statistics, a condition which, evidently, is not giving satisfactory results. Better results can possibly be obtained by the Federal Government passing legislation whereby it can co-operate with the several provinces, to ameliorate these conditions.

This question may evoke discussion, and even objections, but it can be proven that this dual tendency in the United States—making for co-operation between the Federal Government and the respective State Legislatures—is an object lesson for Canada, since there is a striking parallel as regards mining and operative conditions between

the two countries. The remarkable feature about the movement in the United States is that the initiative began with the States themselves and not with the Federal Government.

This was due to the fact that, for political and other expedient reasons, it was found in practice that the local authorities failed to carry out the provisions even of the existing rules and regulations, hence, due to laxity and looseness of administration, serious accidents, and deplorable loss of life began to increase to an alarming extent.

It was seen, therefore, that strong measures were needed, backed by the sanction of the supreme government authority of the American Commonwealth.

In the United States, Mr. George Harrison, the Chief Inspector of Mines for the State of Ohio, in his annual report, 1908, has a long article on the duties of the Federal and States Governments in relation to the mining industry, and a short paragraph is here quoted as being applicable to Canada.

'In June last a gathering of mine inspectors from various mining states convened in the city of Indianapolis and after considering the seriousness of the situation from increased fatalities in mines, decided to organize an Institution of Mine Inspectors of the United States, with the object in view of mutual assistance and more complete co-operation and concerted action, in securing better and more uniform mining laws.

'While a movement of this kind is in the right and proper direction, and should be encouraged and sustained, there is no doubt a large number of those who favour it go further, and believe that any steps in the direction of better and safer regulations of the operations of mines, to be general and successful, should be of a *national* character, having the *moral* and *material* support, and carrying with it the impetus of the *Federal Government.*

'There may be some differences of opinion as to whether representatives of the Federal Government can exercise any jurisdiction and authority in mines in the various mining states, or what the effect would be on state mining departments, but there is no need for such questions to arise.

'A Federal Bureau of Mines could do very efficient work by investigations in many directions, and in co-operation with state mining departments, without breaking down any of the state constitutional barriers, or in any way interfering with the authority of state mining inspectors in the proper performance of their duties.'

### EXPLOSIVES AND THEIR USE.

Canada has not at the present time what may be called an 'Explosive Act,' such an Act as was passed in the United Kingdom in 1875 (38 Vict., C. 17), whereby the manufacture, storage, carriage, testing, and use of explosives are controlled by the Imperial Government.

The Chief Inspector of Explosives for the United Kingdom, in his official report for 1908, makes the following statement:—

'That notwithstanding the large increase in the manufacture of explosives, the average number of deaths has greatly decreased since the passing of the Explosives Act, whereas the number of fatal accidents with explosives under conditions to which the Act does not apply appears to increase with the extension of trade.'

That the question of explosives has a direct bearing on accidents in mines is obvious from the action taken by President Roosevelt (Senate Records, U.S.A., January 28, 1908, page 1179), when the causes of the large number of accidents occurring in the United States mines were brought to his attention.

In 1908 the United States Government appointed a special commission, consisting of 'Foreign Experts,' to investigate the causes of mine accidents, and to suggest a remedy for the same, namely:—

Victor Watteyne, Inspector General of Mines, Belgium.

Carl Meissner, Councillor for Mines, Germany; and

Arthur Desborough, His Majesty's Inspector of Explosives, Great Britain.

This Committee submitted their report to Secretary Garfield on October 23, 1908. who transmitted it to President Roosevelt, stating that the report with its recommendations would be of the highest importance in aiding Congress, and the different State Legislatures, in enactment of laws and regulations for more effective and careful operations in mining, and thus prevent the serious loss of life which has occurred in recent years.

On the presentation of this report to President Roosevelt, he at once ordered its publication and distribution among the coal mine operators and miners of the United States.

The first recommendation made in the report is marked 'A,' and is headed 'Selecting the Explosives to be used.' It reads as follows:—

'We recommend that the Government of the United States examine the explosives now and hereafter to be used in mining, with a view to eliminate the most dangerous explosives, and to improving and standardizing such explosives as may be consired most suitable for such use; these to be designated as '*Permissible Explosives.*'

That the United States Government took active steps in carrying out in a practical manner the recommendations of the 'Foreign Experts' is demonstrated by the fact that the Technologic Branch, established under the Geological Survey of the United States, straightway built a testing station at Pittsburgh, and made their experiments, which enabled them to issue their first official circular on May 15, 1909, only seven months after the recommendations were submitted to the United States Government.

In all European countries the Federal Governments have established 'Testing Stations' for proving explosives, and experimenting therewith.

In Canada we have no such station, though all the reports of the mining bureaus of the Provincial Governments draw attention to the large number of deaths and accidents due to explosives, while the press of the country is almost daily recording deaths due to this cause.

On railway construction work we have the same lamentable condition of affairs as exists in connexion with mining. On one section of the Grand Trunk Pacific railway there was a record of seventeen fatal accidents in one year.

In the year 1908 the report of the Inspector of Mines for the Province of Ontario records thirty accidents due to explosives, which is 58·82 per cent of all the accidents reported. In British Columbia for the same year eleven fatal accidents occurred in metalliferous mines, due to explosives, which is 52·4 per cent of all fatal accidents recorded in metal mines in that Province.

These facts do not require comment, they speak forcibly for themselves.

In the preparation of the foregoing case for a reform of the laws relating to effective regulation of mining operations, and the general use of explosives, it has been very difficult to obtain reliable data, due to the fact that there is no systematic collection of information in the Dominion by any central authority.

The statistics gathered by the mining bureaus of the respective provinces are not available for use by the Dominion Government until many months after the accidents have happened. If, however, it is necessary for the railway companies in the Dominion to report all accidents—no matter how slight—to the Board of Railway Commissioners of the Federal Government, who have authority granted by Act of Parliament to investigate any or every case reported, why should not like authority be vested in the Department of Mines?

No uniform system of classification exists in any of the provinces of Canada for the collection of statistics of accidents in mines, their cause and results; or as to how long an injured or disabled person is prevented from following his daily occupation.

In Great Britain this problem has been solved by the adoption of uniform laws and regulations, administered under the direct authority of the Home Secretary.

In the United States the mine inspectors of the various states are a unit in appealing to the Federal Government for the enactment of uniform mining laws adapted to conditions in the United States.

The proposed legislation is based upon the suggested remedies contained in the report of the special commission of 'Foreign Experts' already referred to.

In one respect Canada is already ahead of the United States, namely, it has established a Department of Mines, with authority to investigate the mining and metallurgical resources of the Dominion; but, unfortunately, at the present time, there is no legislation regulating mining and other similar operations, whereby it is possible to insist upon efficient measures for the prevention of injuries and loss of life in the various industries.

What is needed is an amendment of the 'Geological and Mines Act,' giving to the Mines Branch authority to call for the immediate reporting of accidents; powers to co-operate with mining authorities in the formulation of an efficient code of laws and regulations relating to mining and the use of explosives; and with sanction to verify statements and to investigate causes.

### SUGGESTIONS FOR AN EXPLOSIVES ACT.

With regard to explosives, as already stated, no Federal Act exists.

In this respect Canada stands unique; for in every other civilized country laws relating to explosives have been enacted.

It is an interesting fact that all the European countries have based their laws relating to explosives on the British code of 1875, modified, of course, to suit local conditions.

Two reasons have been assigned for the almost universal adoption of the British code:—

(1) Because it was not only the first, but, being based upon wide experience of mining conditions throughout the empire, its provisions were wisely conceived.

(2) The results in the prevention of injuries and loss of life have been so satisfactory as to be the admiration of all nations.

STATEMENT showing Fatal and Serious Accidents in the Coal Mines of British Columbia and Nova Scotia, and comparative statement of the Fatal Accidents in Great Britain and the United States of America.

| Year. | British Columbia. — Output of Coal in Tons. | British Columbia. — Number of Men Employed. | British Columbia. — Accidents. | | | British Columbia. — Ratio per 1,000 Men Employed. | | | Nova Scotia. — Output of Coal in Tons. | Nova Scotia. — Number of Men Employed. | Nova Scotia. — Accidents. | | | Nova Scotia. — Ratio per 1,000 Men Employed. | | | Great Britain. — Fatal Accidents, Ratio per 1,000 Men Employed. | United States. — Fatal Accidents, Ratio per 1,000 Men Employed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fatal. | Serious. | Slight. | Fatal. | Serious. | Slight. | | | Fatal. | Serious. | Slight. | Fatal. | Serious. | Slight. | | |
| 1899 | 1,306,324 | 3,780 | 11 | 29 | 30 | 2·91 | 7·67 | 7·94 | 2,642,333 | 5,612 | 19 | 26 | 4 | 3·39 | 4·65 | 0·07 | 1·26 | 2·98 |
| 1900 | 1,590,179 | 4,178 | 17 | 43 | 38 | 4·06 | 10·09 | 9·07 | 3,238,245 | 6,626 | 21 | 18 | 13 | 3·17 | 2·17 | 1·20 | 1·30 | 3·24 |
| 1901 | 1,691,557 | 3,974 | 102 | 34 | 31 | 25·67 | 8·59 | 7·88 | 3,625,365 | 7,663 | 14 | 33 | 8 | 1·82 | 4·30 | 1·04 | 1·36 | 3·24 |
| 1902 | 1,641,626 | 4,011 | 139 | 21 | 18 | 34·65 | 5·23 | 4·48 | 4,366,869 | 8,062 | 21 | 26 | 12 | 2·60 | 3·22 | 1·49 | 1·24 | 3·49 |
| 1903 | 1,481,913 | 4,264 | 42 | 33 | 26 | 9·85 | 7·74 | 6·09 | 5,255,247 | 11,092 | 31 | 64 | 9 | 2·88 | 5·76 | 0·81 | 1·27 | 3·14 |
| 1904 | 1,685,698 | 4,453 | 37 | 41 | 16 | 8·31 | 9·20 | 3·59 | 5,247,135 | 11,659 | 27 | 55 | 33 | 2·40 | 4·71 | 2·83 | 1·24 | 3·38 |
| 1905 | 1,825,832 | 4,467 | 12 | 30 | 26 | 2·72 | 7·03 | 5·99 | 5,050,420 | 10,780 | 20 | 55 | 19 | 1·85 | 5·10 | 1·76 | 1·35 | 3·53 |
| 1906 | 1,899,076 | 4,805 | 15 | 36 | 32 | 3·12 | 7·49 | 6·66 | 5,866,605 | 12,123 | 29 | 58 | 16 | 2·39 | 4·79 | 1·32 | 1·29 | 3·40 |
| 1907 | 2,219,608 | 6,059 | 31 | 61 | 62 | 5·11 | 10·06 | 10·23 | 5,720,660 | 12,107 | 37 | 59 | 22 | 3·05 | 4·87 | 1·81 | 1·32 | 4·86 |
| 1908 | 2,109,387 | 6,095 | 18 | 50 | 52 | 2·95 | 8·20 | 8·53 | 6,299,282 | 12,933 | 45 | 97 | 82 | 3·48 | 7·50 | 6·34 | 1·32 | * 3·55 |
| Totals and Averages | 17,451,200 | 46,036 | 424 | 378 | 331 | 9·21 | 8·21 | 7·19 | 47,312,161 | 98,657 | 264 | 493 | 218 | 2·67 | 4·99 | 2·21 | 1·295 | 3·48 |

* 20 per cent less production in this year.

STATEMENT showing the Number of Persons Employed, Fatal Accidents, and Ratio per 1,000 Men Employed, in the Mines of British Columbia, Ontario, Nova Scotia, and Quebec, and Comparative Statement with other Countries.

| Provinces. | Year 1906. | | | | Death Rate per 1,000 Employed. | Year 1907. | | | | Death Rate per 1,000 Employed. | Year 1908. | | | | Death Rate per 1,000 Employed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Employed Under Ground. | Employed Above Ground. | Total Employed. | Number of Deaths. | | Employed Under Ground. | Employed Above Ground. | Total Employed. | Number of Deaths. | | Employed Under Ground. | Employed Above Ground. | Total Employed. | Number of Deaths. | |
| British Columbia— | | | | | | | | | | | | | | | |
| Coal | 3,415 | 1,390 | 4,805 | 15 | 3·12 | 4,389 | 1,670 | 6,059 | 31 | 5·12 | 4,432 | 1,641 | 6,073 | 18 | 2·95 |
| Metal | 2,535 | 1,183 | 3,718 | 17 | 4·57 | 2,585 | 1,112 | 3,697 | 20 | 5·41 | 2,448 | 1,089 | 3,537 | 21 | 5·93 |
| Ontario— | | | | | | | | | | | | | | | |
| Copper-Nickel | ..... | ..... | 2,227 | 4 | 2·45 | ..... | ..... | 1,824 | 4 | 2·10 | ..... | ..... | ..... | 15 | ... |
| Silver and Iron | ..... | ..... | 1,057 | 3 | 2·84 | ..... | ..... | 2,038 | 15 | 7·36 | 1,089 | 1,325 | ..... | 32 | 24·8 |
| Nova Scotia— | | | | | | | | | | | | | | | |
| Coal | 9,301 | 2,738 | 12,039 | 28 | 2·31 | 9,507 | 2,580 | 12,087 | 37 | 3·05 | 10,152 | 2,781 | 12,933 | 45 | 3·48 |
| Metal | ..... | ..... | ..... | 6 | 11·61 | ..... | ..... | ..... | 2 | 4·14 | ..... | ..... | 581 | ..... | .... |
| Quebec | ..... | ..... | ..... | ..... | 1·23 | ..... | ..... | ..... | ..... | 1·46 | ..... | ..... | ..... | ..... | ... |
| United Kingdom— | | | | | | | | | | | | | | | |
| Coal | 697,129 | 170,032 | 867,161 | 1,116 | 1·29 | 745,197 | 179,900 | 925,097 | 1,216 | 1·32 | 796,329 | 191,484 | 987,813 | 1,304 | 1·32 |
| Metal | 30,242 | 15,181 | 45,424 | 62 | 1·36 | 31,259 | 15,864 | 47,123 | 63 | 1·33 | 17,417 | 12,510 | 29,927 | 37 | 1·23 |
| Germany— | | | | | | | | | | | | | | | |
| Coal | ..... | ..... | 569,745 | 1,073 | 1·90 | ..... | ..... | 609,575 | 1,562 | 2·64 | ..... | ..... | ..... | ..... | .... |
| Metal | ..... | ..... | 89,764 | 88 | 0·98 | ..... | ..... | 82,680 | 110 | 1·33 | ..... | ..... | ..... | ..... | .... |
| France— | | | | | | | | | | | | | | | |
| Coal | 129,624 | 48,807 | 178,431 | 1,280 | 7·17 | 133,117 | 50,745 | 183,862 | 202 | 1·10 | ..... | ..... | ..... | ..... | .... |
| Metal | 14,709 | 5,937 | 20,646 | 51 | 2·47 | 16,305 | 7,892 | 24,197 | 55 | 2·27 | ..... | ..... | ..... | ..... | .... |
| United States (4 states)— | | | | | | | | | | | | | | | |
| Coal | ..... | ..... | 640,780 | 2,092 | 3·20 | ..... | ..... | 680,492 | 3,156 | 4·86 | ..... | ..... | 690,438 | 2,450 | 3·55 |
| Metal | ..... | ..... | 85,369 | 251 | 2·93 | ..... | ..... | 87,848 | 248 | 2·83 | ..... | ..... | ..... | ..... | 3·17 |

## REPORTS, BULLETINS, MAPS, ETC., PUBLISHED IN 1909. BY THE MINES BRANCH.

### Reports.

No.

20. Iron Ore Deposits of Nova Scotia (Part I). By Dr. J. E. Woodman.
22. On the Examination of some Iron Ore Deposits in the Districts of Thunder Bay and Rainy River, Ont. By F. Hille, M. E.
23. Iron Ore Deposits along the Ottawa (Quebec side) and Gatineau rivers. By Fritz Cirkel, M.E.
25. On the Tungsten Ores of Canada. By T. L. Walker, M.A., Ph. D.
26. Annual Report of the Mineral Production of Canada, 1906. By John McLeish, B.A.
27. Preliminary Report on the Mineral Production of Canada for the calendar year 1908. By John McLeish, B.A.
28. Summary Report of Mines Branch, 1908.
29. Chrome Iron Ores of the Eastern Townships. By Fritz Cirkel, M.E. (Supplementary Section: Experiments with Chromite at McGill University. By Dr. J. B. Porter).
30. Investigations of the Peat Bogs and Peat Fuel Industry of Canada, 1908. (Two editions). Bulletin No. 1. By Erik Nystrom, M.E., and A. Anrep, Peat Expert.
32. On the Investigation of an Electric Shaft Furnace, Domnarfvet, Sweden, etc. (Two editions). By Dr. Eugene Haanel.
31. The Production of Cement in Canada during the calendar year 1908. By John McLeish, B.A.
42. Production of Iron and Steel in Canada during the calendar years 1907 and 1908. By John McLeish, B.A.
43. Production of Chromite in Canada during the calendar years 1907 and 1908. By John McLeish, B.A.
44. Production of Asbestos in Canada during the calendar years 1907 and 1908. By John McLeish, B.A.
45. Production of Coal, Coke, and Peat in Canada during the calendar years 1907 and 1908. By John McLeish, B.A.
46. Production of Natural Gas and Petroleum in Canada during the calendar years 1907 and 1908. By John McLeish, B.A.
47. Iron Ore Deposits of Vancouver and Texada islands, B.C. By Einar Lindeman. M.E.
55. Bituminous or Oil-shales of New Brunswick and Nova Scotia; also on the Oil-shale Industry of Scotland, Part I. By R. W. Ells, LL.D., F.R.S.C.
62. Preliminary Report on the Mineral Production of Canada for the calendar year 1909. By John McLeish, B.A.

Schedule of Charges for Chemical Analyses and Assays:—

### Maps.

33. Magnetometric Survey, Vertical Intensity: Lot 1, Concession VI, Mayo township, Hastings county, Ont. By Howells Fréchette, M.Sc.
34. Magnetometric Survey, Vertical Intensity: Lots 2 and 3, Concession VI, Mayo township, Hastings county, Ont. By Howells Fréchette, MSc.

35. Magnetometric Survey, Vertical Intensity: Lots 10, 11, and 12, Concession IX, and Lots 11 and 12, Concession VIII, Mayo township, Hastings county, Ont. By Howells Fréchette, M.Sc.
36. Survey of Mer Bleue Peat Bog, Gloucester township, Carleton county, and Cumberland township, Russell county, Ont. By Erik Nystrom, M.E., and A. Anrep, Peat Expert.
37. Survey of Alfred Peat Bog, Alfred and Caledonia townships, Prescott county, Ont. By Erik Nystrom, M.E., and A. Anrep, Peat Expert.
38. Survey of Welland Peat Bog, Wainfleet and Humberstone townships, Welland county, Ont. By Erik Nystrom, M.E., and A. Anrep, Peat Expert.
39. Survey of Newington Peat Bog, Osnabruck, Roxborough, and Cornwall townships. Stormont county, Ont. By Erik Nystrom, M.E., and A. Anrep, Peat Expert.
40. Survey of Perth Peat Bog, Drummond township, Lanark county, Ont. By Erik Nystrom, M.E., and A. Anrep, Peat Expert.
41. Survey of Victoria Road Peat Bog, Bexley and Carden townships, Victoria county, Ont. By Erik Nystrom, M. E., and A. Anrep, Peat Expert.
48. Magnetometric Map of Iron Crown claim at Klaanch river, Vancouver island, B.C. By Einar Lindeman, M.E.
49. Magnetometric Map of Western Steel Iron claim, at Sechart, Vancouver island, B.C. By Einar Lindeman, M.E.
50. Vancouver island, B.C. By Einar Lindeman, M.E.
51. Iron Mines, Texada island, B.C. By F. H. Shephard, C.E.
52. Sketch Map of Bog Iron Ore Deposits, West Arm, Quatsino sound, Vancouver island, B.C. By L. Frank.
53. Iron Ore Occurrences, Ottawa and Pontiac counties, Que., 1908. By J. White and Fritz Cirkel, M.E.
54. Iron Ore Occurrences, Argenteuil county, Que., 1908. By Fritz Cirkel, M.E.
57. The Productive Chrome Iron Ore District of Quebec. By Fritz Cirkel, M.E.
60. Magnetometric Survey map of the Bristol Mine, Pontiac county, Que. By Einar Lindeman, M.E.
61. Topographic map of Bristol Mine, Pontiac county, Que. By Einar Lindeman, M.E.

## ACCOUNTANT'S STATEMENT.

**Statement of Appropriation and Expenditure by Mines Branch for year ended March 31, 1909:—**

| — | Appropriation. | Expenditure. |
|---|---|---|
| | $ cts. | $ cts. |
| Amount voted by Parliament | 121,729 16 | |
| Civil list salaries | | 26,929 14 |
| Coal tests | | 18,486 29 |
| Publication of reports and maps | | 15,259 35 |
| Wages | | 11,975 68 |
| Investigations *re* peat and coal | | 11,761 01 |
| Travelling expenses | | 2,452 02 |
| Fuel testing plant | | 2,371 50 |
| Investigations *re* iron ores | | 1,890 48 |
| Laboratory | | 1,536 80 |
| Mining and metallurgical industries | | 1,309 98 |
| Printing, stationery, and mapping materials | | 1,233 73 |
| Investigations of oil-shales | | 823 84 |
| Monograph on asbestos | | 662 09 |
| " gypsum | | 409 55 |
| Miscellaneous | | 323 48 |
| Instruments | | 284 75 |
| Books and periodicals | | 128 25 |
| Balance unexpended and lapsed | | 24,381 22 |
| | | 122,219 16 |
| *Less* paid from appropriations 1907–8 | | 490 00 |
| | 121,729 16 | 121,729 16 |

(Signed) JOHN MARSHALL,
*Accountant, Department of Mines.*

## APPENDICES.

I. Mineral Production in Canada in 1909.

II. Description of Commercial Methods and Apparatus for the Analysis of Oil-shales.

III. U. S. Report on Mine Explosions: By Foreign Exports.

IV. On the Examination of Magnetic Iron Ores.

## APPENDIX I.

## PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA DURING THE CALENDAR YEAR 1909: WITH REVISED STATISTICS FOR 1908.

*Letter of Transmittal.*

EUGENE HAANEL, Ph.D.,
Director of Mines.

SIR,—I beg to submit herewith, the annual preliminary report on the mineral production of Canada in 1909, including a table showing the revised statistics of production in 1908.

The figures of production given for 1909 are, of necessity, subject to revision, since at this time, in many instances, producers of metallic ores have not themselves received complete returns from smelters. For these and other reasons, estimates have to be made. It is hoped, however, that this preliminary statement may serve to give a general idea of the gross output of the mineral industry during the year.

When more complete information is available, the annual report will be prepared. It will contain the final statistics in greater detail, as well as information relating to exploration, development, prices, markets, imports, exports, etc.

Special acknowledgments are due to the many mining operators and managers or owners of smelting establishments who have promptly furnished statements of their production.

I am, Sir, your obedient servant,

(Signed) JOHN McLEISH.

Division of Mineral Resources and Statistics.

## THE MINERAL PRODUCTION OF CANADA IN 1908.

(Revised.)

| Product. | | Quantity. (a) | Value. (b) |
|---|---|---|---|
| METALLIC. | | | $ |
| Antimony ore (exports) | Tons. | 148 | 5,443 |
| Copper (c) | Lbs. | 63,702,873 | 8,413,876 |
| Gold | Ozs. | 476,112 | 9,842,105 |
| Pig iron from Canadian ore (d) | Tons. | 99,420 | 1,664,302 |
| Lead (e) | Lbs. | 43,195,733 | 1,814,221 |
| Nickel (f) | " | 19,143,111 | 8,231,538 |
| Cobalt | | | 113,423 |
| Silver (g) | Ozs. | 22,106,233 | 11,686,239 |
| Zinc ore | Tons. | 452 | 3,215 |
| Total | | | 41,774,362 |
| NON-METALLIC. | | | |
| Arsenic | | | 58,566 |
| Asbestos | Tons. | 66,548 | 2,555,361 |
| Asbestic | " | 24,225 | 17,974 |
| Calcium carbide | " | 6,864 | 417,150 |
| Chromite | " | 7,225 | 82,008 |
| Coal | " | 10,886,311 | 25,194,573 |
| Corundum | " | 1,089 | 100,398 |
| Feldspar | " | 7,877 | 21,099 |
| Graphite | " | 251 | 5,565 |
| " artificial | " | 214 | |
| Grindstones | " | 3,843 | 48,128 |
| Gypsum | " | 340,964 | 575,701 |
| Limestone for flux in iron furnaces | " | 418,661 | 289,705 |
| Magnesite | " | 120 | 840 |
| Mica | " | 436 | 139,871 |
| Mineral pigments—Barytes | " | 4,312 | 19,021 |
| " Ochres | " | 4,746 | 30,440 |
| Mineral water | | | 151,953 |
| Natural gas (h) | | | 1,012,660 |
| Peat | Tons. | 60 | 180 |
| Petroleum (i) | Bls. | 527,987 | 747,102 |
| Phosphate | Tons. | 1,596 | 14,794 |
| Pyrites | " | 47,336 | 224,824 |
| Quartz | " | 44,741 | 52,830 |
| Salt | " | 79,975 | 378,798 |
| Talc | " | 1,016 | 3,048 |
| Tripolite | " | 30 | 195 |
| Total | | | 32,142,784 |

(a) Quantity of product sold or shipped.

(b) The metals, copper, lead, nickel, and silver are for statistical and comparative purposes valued at the final average value of the refined metal in New York. Pig iron is valued at the furnace and non-metallic products at the mine or point of shipment.

(c) Copper contents of ore, matte, etc., at 13·208 cents per pound.

(d) The total production of pig iron in Canada in 1908 was 630,835 short tons valued at $8,111,194, of which it is estimated about 99,420 tons valued at $1,664,302 should be attributed to Canadian ore and 531,415 tons valued at $6,446,892 to the ore imported.

(e) Lead contents of ore, matte, etc., at 4·200 cents per lb.

(f) Nickel contents of matte shipped at 43 cents per lb.

(g) Silver contents of ore, etc., at 52·864 cents per lb.

(h) Gross return from sale of gas.

(i) Deduced from the amount paid in bounties and valued at $1.41½ per barrel.

## THE MINERAL PRODUCTION OF CANADA IN 1908—*Concluded.*

(Revised.)

| Product. | | Quantity. (a) | Value. (b) |
|---|---|---|---|
| Structural Material and Clay Products. | | | $ |
| Cement, natural | Bls. | 1,044 | 815 |
| " Portland | " | 2,665,289 | 3,709,139 |
| Clay products— | | | |
| Bricks, common | No. | 408,305,768 | 2,982,255 |
| " pressed | " | 53,480,764 | 517,180 |
| " paving | " | 3,719,961 | 59,456 |
| " moulded and ornamental | | | 18,535 |
| Fireclay and fireclay products | | | 110,302 |
| Fireproofing and architectural terra-cotta | | | 170,211 |
| Pottery | | | 200,541 |
| Sewer pipe | | | 514,362 |
| Tiles, drain | No. | 20,100,261 | 298,561 |
| Lime | Bus. | 3,601,468 | 712,947 |
| Stone— | | | |
| Building stone | | | 1,800,000 |
| Flagstones | No. | 61,200 | 6,293 |
| Granite | Tons. | | 282,320 |
| Slate | Squares. | 2,950 | 13,496 |
| Sand-lime brick | No. | 17,288,260 | 152,856 |
| Sand and gravel (exports) | Tons. | 298,954 | 161,387 |
| Total, structural material, etc | | | 11,710,656 |
| " all other non-metallic | | | 32,142,784 |
| Total, non-metallic | | | 43,853,440 |
| " metallic | | | 41,774,362 |
| Estimated value of mineral products not reported | | | 300,000 |
| Total value, 1908 | | | 85,927,802 |

## ANNUAL MINERAL PRODUCTION IN CANADA SINCE 1886.

| | | | |
|---|---|---|---|
| 1886 | $10,221,255 | 1898 | $38,412,431 |
| 1887 | 10,321,331 | 1899 | 49,234,005 |
| 1888 | 12,518,894 | 1900 | 64,420,983 |
| 1889 | 14,013,113 | 1901 | 65,804,611 |
| 1890 | 16,763,353 | 1902 | 63,211,634 |
| 1891 | 18,976,616 | 1903 | 61,740,513 |
| 1892 | 16,623,415 | 1904 | 60,073,897 |
| 1893 | 20,035,082 | 1905 | 69,525,170 |
| 1894 | 19,931,158 | 1906 | 79,057,308 |
| 1895 | 20,505,917 | 1907 | 86,865,202 |
| 1896 | 22,474,256 | 1908 | 85,927,802 |
| 1897 | 28,485,023 | | |

# PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA IN 1909.

(Subject to revision.)

| Product. | | Quantity. (a) | Value. (b) |
|---|---|---|---|
| METALLIC. | | | $ |
| Copper (c) | Lbs. | 54,061,106 | 7,018,213 |
| Gold | | | 9,790,000 |
| Pig iron from Canadian ore (d) | Tons. | 149,444 | 2,222,215 |
| Iron ore (exports) | " | 21,956 | 61,965 |
| Lead (e) | Lbs. | 45,857,424 | 1,959,488 |
| Nickel (f) | " | 26,282,991 | 9,461,877 |
| Cobalt | | | * 66,319 |
| Silver (g) | Ozs. | 27,878,590 | 14,358,310 |
| Zinc | | | 250,000 |
| Total value, metallic | | | 45,188,387 |
| NON-METALLIC. | | | |
| Arsenic | Tons. | 1,129 | 64,100 |
| Asbestos | " | 63,349 | 2,284,587 |
| Asbestic and asbestic sand | " | 23,951 | 17,188 |
| Chromite (exports) | " | 1,794 | 20,858 |
| Coal | " | 10,411,955 | 24,431,351 |
| Corundum | " | 1,491 | 157,398 |
| Feldspar | " | 10,286 | 35,694 |
| Graphite | " | 730 | 37,624 |
| Grindstones | " | 3,965 | 50,944 |
| Gypsum | " | 468,551 | 667,816 |
| Magnesite | " | 330 | 2,508 |
| Mica | " | | 154,106 |
| Mineral pigments— | | | |
| Ochres and barytes | " | 4,119 | 29,213 |
| Mineral waters | | | 177,304 |
| Natural gas (h) | | | 1,205,943 |
| Petroleum (i) | Bls. | 420,755 | 559,604 |
| Phosphate (apatite) | Tons. | 597 | 4,618 |
| Pyrites | " | 57,038 | 196,312 |
| Quartz | " | 50,541 | 63,032 |
| Salt | " | 84,037 | 415,219 |
| Talc | " | 4,506 | 12,172 |
| Total value, non-metallic | | | 30,587,591 |

(a) Quantity of product sold or shipped.

(b) The metals, copper, lead, nickel, and silver are for statistical and comparative purposes valued at the final average value of the refined metal in New York. Pig iron is valued at the furnace and non-metallic products at the mine or point of shipment.

(c) Copper contents of smelter products and ores exported, at 12·982 cents per pound.

(d) The total production of pig iron in Canada in 1909 was 757,162 tons valued at $9,581,864, of which it is estimated 607,718 tons valued at $7,359,649 should be credited to imported ores.

(e) Refined lead and lead contained in base bullion exported at 4·273 cents per pound.

(f) Nickel contents of matte produced, at 36 cents per pound (the lowest quotation for nickel in New York less 10 per cent). The value of the nickel contained in the matte was, as returned by the operators, $2,810,748, or an average per pound of 10·7 cents.

(g) Estimated recoverable silver at 51·503 cents per ounce.

(h) Gross returns for sale of gas.

(i) Quantity on which bounty was paid and valued at $1.33 per barrel.

* Additional returns increase this item to $90,950.

# PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA IN 1909—(*Concluded.*)

(Subject to revision.)

| Product. | | Quantity. (*a*) | Value. (*b*) |
|---|---|---|---|
| STRUCTURAL MATERIAL AND CLAY PRODUCTS. | | | $ |
| Cement, Portland | Bls. | 4,010,180 | 5,266,008 |
| Clay products— | | | |
| Brick | | | 4,200,000 |
| Sewer pipe, fireclay, drain tile, etc | | | 1,300,000 |
| Lime | Bus. | 5,163,874 | 1,049,473 |
| Sand and gravel (exports) | Tons. | 481,584 | 256,166 |
| Stone— | | | |
| Granite | | | 340,047 |
| Limestone for flux in blast furnaces | | | 328,091 |
| Marble, limestone, and sandstone | | | 1,600,000 |
| Total structural material and clay products | | | 14,339,785 |
| All other non-metallic | | | 30,587,591 |
| Total value, non-metallic | | | 44,927,376 |
| Total value, metallic | | | 45,188,387 |
| Estimated value of mineral products not reported | | | 300,000 |
| Total value, 1909 | | | 90,415,763 |

## REMARKS.

The preliminary table of mineral production in Canada given herewith, shows the total value of the production in 1909 to have been in excess of $90,000,000. Compared with the total value for 1908, which was $85,927,802, the production of 1909 shows an increase of a little over 5 per cent. The actual increase or betterment in the mining industry in 1909 was, however, somewhat greater than is indicated by this comparison. Owing to a slight change in the method of compiling statistics of the quantities of metals produced, the values for 1909 are somewhat less than they would otherwise have been.

Of the total production in 1909, $45,188,387—or 49·9 per cent of the total—is credited to the metals, and $44,927,376—or 49·7 per cent—to non-metallic products; a small allowance being made for mineral products not reported. Amongst the individual products coal is still the most important, its value constituting 27 per cent of the total; silver occupies second place with 15·9 per cent; gold and nickel come next with 10·8 and 10·5 per cent respectively; copper contributes 7·8 per cent; cement 5·8 per cent; clay products 6·1 per cent; asbestos 2·5 per cent.

The metals nearly all showed an increased output compared with 1908. The average prices remained fairly steady throughout the year, differing but slightly from those of the year before; copper, nickel, and silver, being lower in price; while lead, spelter, and tin, were higher.

A comparison of New York average monthly prices is shown herewith.

### Average monthly prices of metals, 1906-9.

| — | 1906. | 1907. | 1908. | 1909. |
|---|---|---|---|---|
| | Cts. | Cts. | Cts. | Cts. |
| Copper | 19·278 | 20·004 | 13·208 | 12·982 |
| Lead | 5·657 | 5·325 | 4·200 | 4·273 |
| Nickel | 41·64 | 45·000 | 43·000 | 40·000 |
| Silver | 66·791 | 65·327 | 52·864 | 51·503 |
| Spelter | 6·198 | 5·962 | 4·720 | 5·503 |
| Tin | 39·819 | 38·166 | 29·465 | 29·725 |

In the non-metallic class there is a larger number of products showing increases than those showing decreases. The coal production was seriously reduced by the labour troubles in Nova Scotia. The asbestos shipments were somewhat less, and petroleum production shows a considerable falling off. In nearly all of the other items, however, there were important increases: particularly in corundum, gypsum, natural gas, salt, and in the structural materials, cement, clay products, lime and stone.

#### SMELTER PRODUCTION.

General statistics of smelter production were collected by this Branch for the first time in 1908, and the aggregate results of these operations during the past two years are shown in the accompanying table. It should be explained, also, that the figures include the results of the treatment of a small quantity of imported ores. The results of the operations at the smelter at Northport, Wash.,—treating chiefly Canadian ores—have been included.

### Smelter and Refinery Production in Canada, 1908 and 1909.

| — | | 1908. | | 1909. | |
|---|---|---|---|---|---|
| | | Refined Products. | Metals contained in matte, blister, base bullion, and speiss exported. | Refined Products. | Metals contained in matte, blister, base bullion, and speiss exported. |
| Gold | Ozs. | 15,436 | 203,300 | 18,241 | 200,129 |
| Silver | " | 11,168,689 | 3,271,899 | 14,242,545 | 4,845,920 |
| Lead | Lbs. | 36,549,274 | 1,116,792 | 41,883,614 | 3,973,810 |
| Copper | " | .......... | 51,965,289 | .......... | 53,328,583 |
| Copper sulphate | " | 203,379 | .......... | 51,405 | .......... |
| Nickel | " | .......... | 19,506,251 | .......... | 27,041,857 |
| Cobalt | " | .......... | 692,170 | .......... | 1,721,083 |
| White arsenic | " | 1,431,052 | .......... | 2,258,087 | .......... |
| Arsenic | " | .......... | 436,787 | .......... | 1,074,516 |

The total ore charged to the furnaces in 1909 was 2,377,780 tons, of which slightly over 40,000 tons were imported. The smelter products exported for refining included, in 1908, copper matte, 7,649 tons; blister copper, 15,418 tons; Bessemer nickel-copper matte, 21,210 tons, and silver-cobalt-nickel speiss, 1,326 tons. In 1909 these smelter products were: base bullion, 2,010 tons; copper matte, 11,597 tons; blister copper, 14,239 tons; Bessemer nickel-copper matte, 25,845 tons; silver-cobalt-nickel speiss, 2,660 tons.

*Gold.*—A preliminary estimate shows a slight decrease in gold production in 1909. The total production in 1908 was $9,842,105, to which the Yukon district contributed $3,600,000; British Columbia, $5,929,880; Nova Scotia, $244,799. In 1909 the Yukon shows a further increase, the value of the gold being estimated at $3,960,000. The total gold exports on which royalty was paid were, according to the records of the Interior Department, during the calendar year, 239,766·35 ounces.

Complete statistics are not yet available as to the gold production in British Columbia, but the returns received appear to indicate a reduced output. The production in Nova Scotia will not differ much from that of the previous year.

*Silver.*—The rapid growth of Canada's silver production which has taken place during the past few years continued during 1909. Increased production is reported from both British Columbia and Ontario. In the first-mentioned Province the silver is recovered with the lead from the galena ores of that Province, of which there was an increased production in 1909. The metal also constitutes an important value in the gold-copper-silver ores smelted.

In British Columbia, silver is recovered as fine metal at Trail and is contained in the matte and blister exported. In Ontario, where the production is practically all from the Cobalt district, a portion of the ores (8,384 tons in 1909) is treated in Canadian metallurgical works producing silver bullion, white arsenic, and a speiss containing silver, cobalt, nickel, etc.; the balance of the ore being exported for treatment abroad. The total production of recoverable silver in Canada is estimated at 27,878,590 ounces valued at $14,358,310, the average price of silver for the year being 51·503 cents.

The price of refined silver varied between a maximum of 53⅞ cents per ounce on May 5, and a minimum of 50¼ cents on March 3.

The production from the Cobalt district again shows a considerable increase over the previous year, but not so large an advance as was made in 1908 over 1907. According to returns received from 31 shipping mines, there were shipped during 1909 about 28,042 tons of ore and 2,967 tons of concentrates, a total tonnage of 31,009. The silver content of ore shipped is returned as 23,581,788 ounces, or an average of 805·284 ounces per ton; and for the concentrates shipped 3,639,475 ounces, or an average of 1,226·651 ounces per ton. Bullion shipped from the mines contained 143,440 fine ounces of silver.

The total silver content of ore, concentrates, and bullion shipped from the mines was 26,364,703 ounces. The mine owners receive payment for only 93 to 98 per cent of the silver content; and in valuing the production a deduction of 5 per cent is made from silver contained in ore and concentrates to cover losses in smelting and refining. On this basis the silver recovery is estimated at 25,128,590 ounces, and valued at $12,941,978. Payments for cobalt content were reported as $90,750; the total value of the year's output was a little over $13,000,000, without deductions for freight and treatment charges.

The number of men employed in shipping mines was reported as 2,768, and wages paid $2,396,742. Incomplete returns of concentration showed 127,271 tons of ore treated, producing 3,213 tons of concentrates.

In 1908 the shipments were 25,682 tons of ore and concentrates containing 19,398,545 ounces of silver, or an average of 755 ounces per ton.

The exports of silver in 1909, for the whole of Canada, as reported by the Customs Department, were 31,126,504 ounces valued at $15,719,909.

*Copper.*—Although refined copper is not produced in Canada, the copper ores are mostly reduced to matte or blister copper carrying additional values in the precious and other metals. Some copper pyrites ore is mined in Quebec province, from which the copper is recovered after the ore has been used as a source of sulphur, and a

small quantity of copper ore is exported from British Columbia coast mines to United States smelters for treatment.

Statistics are not available at the present time to show the total quantity of copper contained in ores shipped from the mines. The total production of copper, however, contained in blister and matte produced and estimated as recoverable from ores exported, was in 1909 approximately 54,061,106 pounds. In 1908 the production of copper, estimated on the same basis, was 52,928,386 pounds, an increased production of about 2 per cent being, therefore, shown in 1909.

Of the production in 1909, Ontario is credited with 15,746,699 pounds and British Columbia wth 37,314,407 pounds. The latter figure may be subject to more or less variation as complete returns had not been received of all ore exported.

The New York price of electrolytic copper varied between the limits of 12 cents and 14⅝ cents per pound, the average monthly price being 12·982 cents, as compared with an average monthly price of 13·208 cents in 1908.

The total exports of copper contained in ore matte and blister, according to Customs Department returns, were 54,447,750 pounds, valued at $5,832,246.

*Lead.*—The total production in 1909 of pig and manufactured lead, and lead contained in base bullion exported was 45,857,424 pounds, valued, at the average price of refined lead in New York, at $1,959,488.

It is possible that there was also some lead ore or lead concentrates exported, of which no record has yet been received. Customs Department statistics indicate such an export of upwards of 2,000,000 pounds.

The production of refined lead, and lead contained in base bullion exported in 1908, was 37,666,066.

Customs Department statistics in this year also indicate an export of lead ore or concentrates, and the total production in 1908 of lead available for consumption was estimated at 40,891,448 pounds; an increased production in 1909 is, therefore, shown of from 5,000,000 to 7,000,000 pounds. This production in both years was all from the Province of British Columbia..

The total amount of bounty paid during the twelve months ending December 31, 1909, on account of lead production was $346,527.98.

The exports of lead in ore, concentrates, base bullion, etc., during the year were 3,116 tons, and of pig lead 5,650 tons, or a total of 8,766 tons. From 14,000 tons to 15,000 tons of domestic production were, therefore, available for home consumption.

The price of lead in New York during 1909 averaged 4·273 cents per pound, varying between 3·95 cents in March and 4·70 cents in December. In 1908 the average was 4·200 cents per pound. The London price per long ton varied between £12 10s. and £13 16s., averaging £13·049.

*Nickel.*—The nickel industry was particularly active during 1909, the largest production on record being shown. Although important quantities of nickel are contained in the cobalt silver ores of Coleman township, the Sudbury district continues to be the chief source of nickel production. The same companies are carrying on active operations: the Mond Nickel Company, at Victoria mines, and the Canadian Copper Company, at Copper Cliff. The ore is first roasted and then smelted to a Bessemer matte containing from 77 to 82 per cent of the combined metals, copper and nickel; the matte being shipped to the United States and Great Britain for refining.

The total production of matte in 1909 was 25,845 tons, valued at the furnaces at $3,913,012. The metallic contents were: copper, 15,746,699 pounds; nickel 26,282,991 pounds.

The aggregate results of the operations on the Sudbury District nickel-copper ores during the past four years are as follows:—

| | 1906. — Tons of 2,000 lbs. | 1907. — Tons of 2,000 lbs. | 1908. — Tons of 2,000 lbs. | 1909. — Tons of 2,000 lbs. |
|---|---|---|---|---|
| Ore mined | 343,814 | 351,916 | 409,551 | 451,892 |
| Ore smelted | 340,059 | 359,076 | 360,180 | 462,336 |
| Bessemer matte produced | 20,364 | 22,041 | 21,197 | 25,845 |
| " shipped | 20,310 | 22,025 | 21,210 | ..... |
| Copper contents of matte shipped | 5,265 | 6,996 | 7,503 | 7,873 |
| Nickel " " " | 10,745 | 10,595 | 9,572 | 13,141 |
| Spot value of matte shipped | $4,628,011 | $3,289,382 | $2,930,989 | $3,913,012 |
| Wages paid | 1,117,420 | 1,278,694 | 1,286,265 | 1,234,904 |
| Men employed | 1,417 | 1,660 | 1,690 | 1,735 |

Exports of nickel contained in ore, matte, etc., as compiled from Customs reports, were for the twelve months ending December 31, as follows:—

| | 1906. — Pounds. | 1907. — Pounds. | 1908. — Pounds. | 1909. — Pounds. |
|---|---|---|---|---|
| To Great Britain | 2,716,892 | 2,518,338 | 2,554,486 | 3,843,763 |
| To United States | 17,936,953 | 16,857,997 | 16,865,407 | 21,772,635 |
| | 20,653,845 | 19,376,335 | 19,419,893 | 25,616,398 |

Nickel contained in silver cobalt ores:—The mine owners received no payment for nickel content and complete statistics are not available as to the total quantity of nickel contained in these ores, of which about 31,009 tons were shipped during 1909. Of the total shipments, 8,384 tons were treated in Canadian metallurgical works at Copper Cliff, Deloro, and Thorold, producing silver bullion and white arsenic; the remaining speiss or residues amounted to 2,660 tons and contained silver, cobalt, nickel, and arsenic, the nickel content totalling 758,966 pounds and the cobalt content, 1,721,083 pounds.

The price of refined nickel in New York was quoted at from 40 to 50 cents per pound, the quotations in December being 'large lots, contract business 40 to 45 cents per pound; retail spot from 50 cents for 2,000 pound lots up to 55 cents for 500 pound lots. The price for electrolytic is 5 cents higher.'

Nickel is quoted on the London market at prices equivalent to, or slightly in excess of those in New York.

*Iron Ore.*—The total shipments of iron ore from mines in Canada in 1909 were 268,043 short tons, valued at $659,120; as compared with 238,082 tons valued at $568,189 in 1908. The shipments in 1909 may be classified as: magnetites 73,420 tons; hematite 190,473 tons; bog ore 3,330 tons; titaniferous magnetite (sand) for experimental purposes 820 tons. In 1898 the ores shipped included magnetite 49,946 tons; hematite 173,164 tons; carbonate ore 4,869 tons; bog ore 10,103 tons.

Exports of ore from Canada during 1909, as recorded by the Customs Department, were 21,956 tons, valued at $61,965.

Although not a portion of the Dominion of Canada, it may be of interest to state the iron ore shipments from Newfoundland during 1909. The two Canadian com-

panies operating the Wabana mines shipped during the year 991,115 gross tons, or 1.110,049 short tons, of which 697,068 tons were shipped to Sydney and 412,981 tons to the United States and Europe.

*Pig Iron.*—An increase of 20 per cent is shown in the production of pig iron in Canada in 1909 as compared with 1908, despite the fact that the Londonderry furnace was out of commission during the whole year. The total production during 1909 was 757,162 short tons, valued at $9,581,864; as compared with 630,835 tons, valued at $8,111,194, in 1908. These figures do not include the output from electric furnace plants, making ferro products, which are situated at Welland and Sault Ste. Marie, Ont., and Buckingham, Que.

Of the total output of pig iron during 1909, 17,003 tons valued at $371,368, or $21.84 per ton, were made with charcoal as fuel, and 740,159 tons valued at $9,210.496, or $12.44 per ton, with coke. The amount of charcoal iron made in 1908 was 6,709 tons, and iron made with coke, 624.126 tons. The classification of the production in 1909, according to the purpose for which it was intended, was as follows: Bessemer, 222.931 tons; basic, 400,921 tons; foundry, including miscellaneous, 116,307 tons.

The amount of Canadian ore used during 1909 was 231,994 tons, imported ore 1,234,990 tons; mill cinder, etc., 25,508 tons. The amount of coke used during the year was 919,271 tons, comprising 412,016 tons from Canadian coal, and 507,255 tons imported coke or coke made from imported coal. The consumption of charcoal was 1,782,258 bushels. Limestone flux was used to the extent of 526,076 tons. In connexion with blast furnace operations there were employed 1,486 men, and $879,426, paid in wages.

The total capacity of 16 completed furnaces was, according to returns received, 2,735 tons. The number of furnaces in blast on December 31, 1909, was 11.

The production of pig iron by provinces in 1908 and 1909 was as follows:—

| Province. | 1908. | | | 1909. | | |
|---|---|---|---|---|---|---|
| | Tons. | Value. | Per ton. | Tons. | Value. | Per ton. |
| | | $ | $ cts. | | $ | $ cts. |
| Nova Scotia | 352,642 | 3,554,540 | 10 08 | 345,380 | 3,453,800 | 10 00 |
| Quebec | 6,709 | 171,383 | 25 55 | 4,770 | 125,623 | 26 34 |
| Ontario | 271,484 | 4,385,271 | 16 15 | 407,012 | 6,002,441 | 14 75 |
| Total | 630,835 | 8,111,194 | 12 86 | 757,162 | 9,581,864 | 12 65 |

*Steel.*—Returns were received from eight steel plants, at which 2,073 men were employed and $1,284,940 paid in wages during 1909. The total production of ingots and castings was 754,719 short tons, with an estimated value of $14,359.710; as compared with 588,763 tons, valued at $10,916,602, in 1908.

Details of production during the two years are as follows:—

| —— | 1908. | | 1909. | |
|---|---|---|---|---|
| | Tons. | $ | Tons. | $ |
| *Ingots*—Open-hearth (basic) | 443,442 | 7,684,277 | 535,988 | 9,372,615 |
| Bessemer (acid) | 135,557 | 2,535,287 | 203,715 | 3,829,012 |
| *Castings*—Open-hearth | 9,051 | 617,126 | 14,013 | 1,043,370 |
| Other steels | 713 | 79,912 | 1,003 | 114,713 |
| Total | 588,763 | 10,916,602 | 754,719 | 14,359,710 |

*Iron and Steel Bounties.*—Following is a statement of the bounties paid on iron and steel during the calendar years 1908 and 1909, as kindly furnished by the Trade and Commerce Department. As no bounty is paid on iron made from mill cinder or ingredients other than ore, the figures do not show the total output of the furnaces, but only those quantities on which bounty was paid.

| | 1908. | | 1909. | |
|---|---|---|---|---|
| | Quantity on which Bounty was paid. | Bounty. | Quantity on which Bounty was paid. | Bounty. |
| | Tons. | $ cts. | Tons. | $ cts. |
| Pig iron made from Canadian ore... | 101,647 | 213,458 34 | 126,297·55 | 214,705 80 |
| Pig iron made from imported ore.... | 517,427 | 569,166 93 | 607,718·09 | 425,402 64 |
| Total, pig iron.................. | 619,074 | 782,628 27 | 734,015·64 | 640,108 44 |
| Steel ingots........................ | 556,289 | 917,876 63 | 729,189·37 | 766,470 41 |
| Steel wire rods..................... | 49,630 | 297,778 68 | 81,405·42 | 488,432 70 |
| Total bounty paid on iron and steel | ................ | 1,998,283 58 | ............ .... | 1,895,011 55 |

*White Arsenic.*—The total output of white arsenic as reported by three firms making this product was 2,258,187 pounds valued at $64,100. In addition, the residues or speiss from these works exported contained 1,074,511 pounds of arsenic. This is all obtained from that portion of the Cobalt ores treated in Canada. No record is available of the total arsenical content of these ores. The exports of arsenic are reported as 3,111,249 pounds valued at $119,673. The production of white arsenic in 1908 was 1,431,000 pounds valued at $41,060, and the arsenical ore and concentrates 986 tons valued at $17,506.

*Asbestos.*—A feature of special interest in connexion with the asbestos industry during 1909 has been the consolidation of interests amongst a number of the larger producers, resulting in the formation of the Amalgamated Asbestos Corporation, Ltd.

While the actual shipments of asbestos were somewhat less in 1909 than in 1908, the stocks on hand at the end of the year are reported considerably larger than on December 31, 1908.

The total shipments of crude and mill stock in 1909 were 63,349 tons valued at $2,284,587, as compared with shipments of 66,548 tons valued at $2,555,361 in 1908; the decrease being 3,199 tons, or 4·8 per cent. The stocks os hand December 31, 1909, were about 20,920 tons, valued approximately at $1,179,679, as compared with stocks on hand December 31, 1908, of 8,669 tons valued at $596,095.

The total shipments, showing details of crude and mill stock, were in 1908 and 1909, as follows:—

| | 1908. | | | 1909. | | |
|---|---|---|---|---|---|---|
| | Short Tons. | Value. | Per ton. | Short Tons. | Value. | Per ton. |
| | | $ | $ cts. | | $ | $ cts. |
| Crude, No. 1 | 857½ | 257,752 | 300 59 | 912·3 | 246,655 | 270 37 |
| " 2 | 2,488 | 411,480 | 165 38 | 2,162 | 328,855 | 152 11 |
| Mill Stock, No. 1 | 5,282½ | 425,448 | 80 54 | 14,776 | 785,731 | 53 18 |
| " 2 | 45,545¼ | 1,345,750 | 29 33 | 32,417 | 800,728 | 24 70 |
| " 3 | 12,374¼ | 114,931 | 9 29 | 13,082 | 122,618 | 9 37 |
| Total asbestos | 66,518 | 2,555,361 | 38 40 | 63,349·3 | 2,284,587 | 36 06 |
| Total asbestic | 24,225 | 17,974 | 0 74 | 23,951 | 17,188 | 0 72 |
| Grand total | 90,773 | 2,573,335 | ........ | 87,300·3 | 2,301,775 | ........ |

Exports of asbestos according to Customs returns were:—

| | Tons. | Value. |
|---|---|---|
| | | $ |
| Twelve months ending December, 1907 | 56,753 | 1,669,299 |
| " " " 1908 | 61,210 | 1,842,763 |
| " " " 1909 | 56,971 | 1,729,857 |

*Corundum.*—The quantity of corundum ore treated during the year was 35,894 tons, from which was produced 1,579 tons of grain corundum. The total shipments were 1,491 tons valued at $157,398, or an average of a little over 5 cents per pound.

*Coal and Coke.*—The total coal production in Canada in 1909, comprising sales and shipments, colliery consumption and coal used in making coke, is estimated at 10,411,955 short tons, valued at $24,431,351. This is a smaller production than in either of the two preceding years, though the total may be slightly increased when more complete returns are received. The western provinces each show an increased production of coal in 1909, but not sufficient to counteract the reduced output in Nova Scotia, which resulted from the coal miners' strike. The aggregate decrease for the whole of Canada was about 474,356 tons, or 4·36 per cent; while Nova Scotia alone showed a falling off of 968,789 short tons, or 14·56 per cent: the aggregate increase in the western provinces being 505,404 tons, or 12·11 per cent.

Of the total production Nova Scotia contributed 54·5 per cent, Saskatchewan and Alberta 20·5 per cent, and British Columbia 24·3 per cent.

The production by provinces was approximately as follows, the figures for 1907 and 1908 being also given:—

| Province. | 1907. | | 1908. | | 1909. | |
|---|---|---|---|---|---|---|
| — | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| | | $ | | $ | | $ |
| Nova Scotia........ .... | 6,354,133 | 12,764,999 | 6,652,539 | 13,364,476 | 5,683,750 | 11,418,249 |
| British Columbia....... | 2,364,898 | 7,390,306 | 2,333,708 | 7,292,838 | 2,538,004 | 7,931,263 |
| Alberta...... .......... | 1,591,579 | 3,836,286 | 1,685,661 | 4,127,311 | 1,978,843 | 4,730,270 |
| Saskatchewan............ | 151,232 | 252,437 | 150,556 | 253,790 | 163,329 | 253,073 |
| New Brunswick.......... | 34,584 | 77,814 | 60,000 | 135,000 | 49,029 | 98,496 |
| Yukon Territory......... | 15,000 | 60,000 | 3,847 | 21,158 | .......... | ..... ...... |
| Totals............... | 10,511,426 | 24,381,842 | 10,886,311 | 25,194,573 | 10,411,955 | 24,431,351 |

The total production of oven coke in 1909 was about 875,080 short tons, valued at $3,557,147, being a slight increase over the production in 1908. At the ovens of the Dominion Iron and Steel Co. at Sydney a quantity of imported coal was used, the supply of domestic coal being insufficient on account of the strike. The Atikokan Iron Company at Port Arthur uses imported coal exclusively. At all other ovens Canadian coal is used. At the end of the year there were in Nova Scotia 670 ovens in operation, 64 idle, and 120 building. In Alberta 226 were in operation and 40 idle, and in British Columbia 767 in operation and 753 idle. The ovens of the Dominion Iron and Steel Co. are of the Otto Hoffman by-product type, and there were recovered as by-products 4,016,834 gallons of tar and 3,351 short tons of sulphate of ammonia.

*Feldspar.*—Total shipments are reported as 10,286 tons valued at $35,694. This includes a quantity of high grade "dental spar" shipped from the Villeneuve mine, Quebec, and valued at from $16 to $20 per ton at Buckingham.

*Petroleum and Natural Gas.*—The production of crude petroleum was as usual nearly all derived from the Ontario peninsula. Direct returns from the producers have not been obtained, but the production upon which bounty was paid, ascertained by the Trade and Commerce Department, was 14,726,433 gallons, of which 3,328 gallons were produced in New Brunswick. This is equivalent to 420,755 barrels, and at an average price of $1.33 per barrel was valued at $559,604. The production in 1908 was 527,987 barrels valued at $747,102, an average per barrel of $1.34, showing a decrease of about 20 per cent in the quantity produced. The total bounty paid in 1909 was $220,896.50, as compared with $277,193.21 in 1908 and $414,157.89 in 1907.

While the production of petroleum has been falling off the receipts from natural gas sold have been increasing. The producing gas wells are located in the counties of Welland, Haldimand, Norfolk, Kent, Essex, and Bruce, in Ontario, and at Medicine Hat and vicinity in Alberta. The total receipts from gas sold in 1909 were about $1,205,943, the figures representing, with one or two exceptions, the total values paid by the consumers.

The quantity of gas sold or used during the year was over 6,000,000 M. feet. Of the total value about 95 per cent is to be credited to Ontario. The total receipts in 1908 were $1,012,660.

*Phosphate.*—The price of this mineral has been increasing. There is a growing demand for it and a revival of phosphate mining appears to be imminent.

*Salt.*—Complete returns of salt production received show total sales of 84,037 tons, valued at $415,219 for the salt alone. Packages used were valued at $175,612; stock on hand at the end of the year was reported as 2,671 tons; 185 men were employed, and $96,116 paid in wages.

*Lime.*—Fairly complete statistics of lime production have been received for 1909. The total sales and shipments are reported as 5,163,874 bushels valued at $1,049,473, or by provinces as follows: Nova Scotia and New Brunswick, 747,696 bushels, valued at $179,380; Quebec, 1,155,167 bushels, valued at $227,253; Ontario, 2,434,686 bushels, valued at $404,782; western provinces, 826,325 bushels, valued at $188,058.

*Portland Cement.*—Complete statistics have been received from all but two cement manufacturers in 1909. These, however, will not increase the totals by more than 2 or 3 per cent. Subject to this correction the total quantity of cement made during the year was 4,089,191 barrels, as compared with 3,495,961 barrels in 1908, an increase of 593,230 barrels, or 17 per cent.

The total quantity of Canadian Portland cement sold during the year was 4,010,180 barrels, as compared with 2,665,289 barrels in 1908, an increase of 1,344,891 barrels, or 50 per cent.

The total consumption of Portland cement in 1909, including Canadian and imported cement, was 4,152,374 barrels, as compared with 3,134,338 barrels in 1908, an increase of 1,018,036 barrels, or 32 per cent.

Detailed statistics of production during the past three years have been as follows:—

| | 1907. | 1908. | 1909. |
|---|---|---|---|
| | Barrels. | Barrels. | Barrels. |
| Portland cement sold | 2,436,093 | 2,665,289 | 4,010,180 |
| " manufactured | 2,491,513 | 3,495,961 | 4,089,191 |
| Stock on hand January 1 | 299,015 | 383,349 | 1,093,493 |
| " December 31 | 354,435 | 1,214,011 | 1,172,504 |
| Value of cement sold | $3,777,328 | $3,709,063 | $5,266,008 |
| Wages paid | 956,080 | 1,274,638 | 1,182,090 |
| Men employed | 1,786 | 3,029 | 2,411 |

The average price per barrel at the works in 1909 was $1.31, as compared with $1.39 in 1908.

The imports of Portland cement into Canada during the twelve months ending December 31, 1909, were 497,678 cwt., valued at $166,669. This is equivalent to 142,194 barrels of 350 pounds, at an average price per barrel of $1.17. The imports in 1908 were 469,049 barrels, valued at $531,045, or an average price per barrel of $1.13. The duty is 12½ cents per hundred pounds.

As there is very little cement exported from Canada, the consumption is practically represented by the Canadian sales together with the imports.

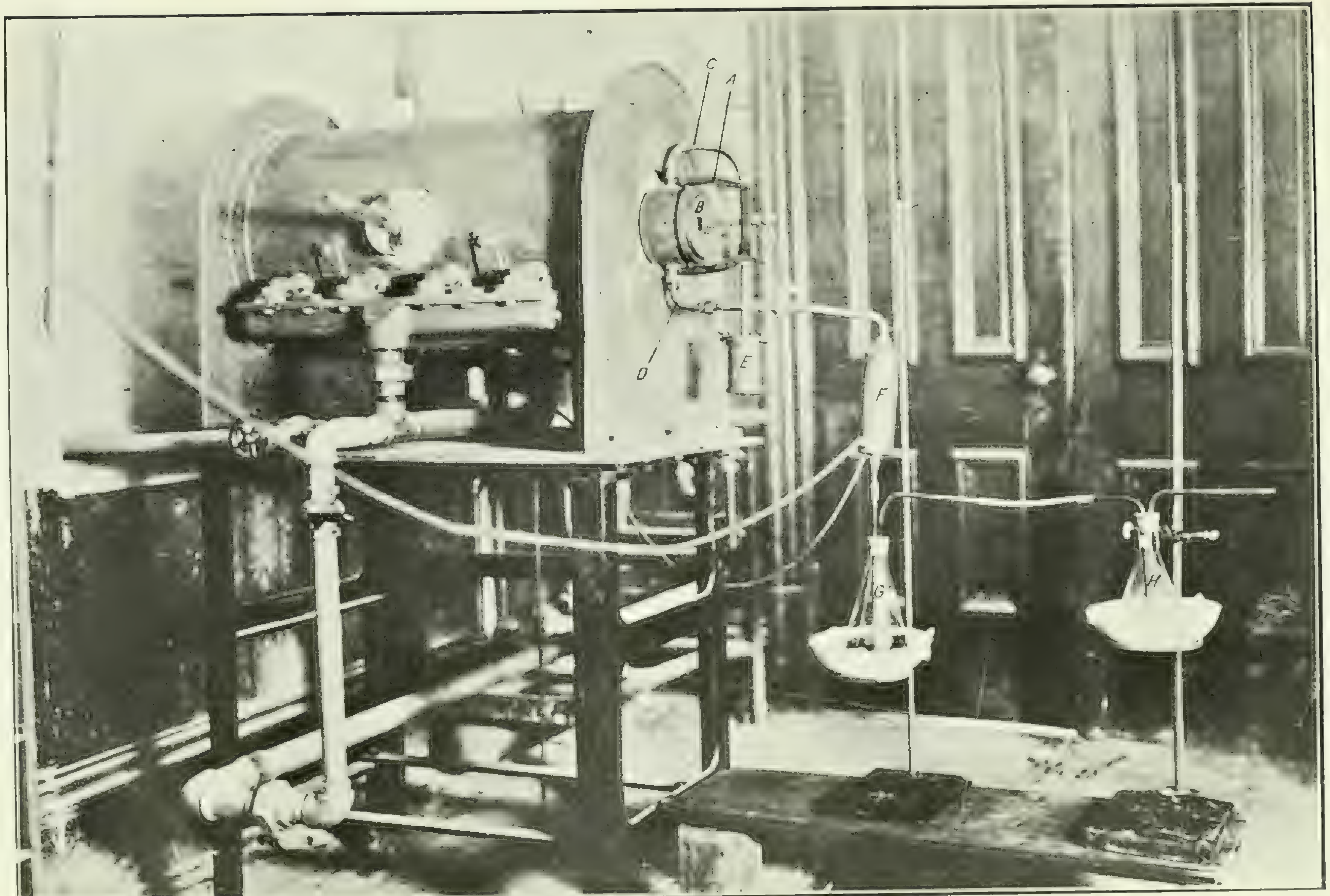
Following is an estimate of the Canadian consumption of Portland cement for the past five years:—

| Calendar Years. | Canadian. | | Imported. | | Total. | |
|---|---|---|---|---|---|---|
| | Barrels. | Per cent. | Barrels. | Per cent. | Barrels. | Per cent. |
| 1905 | 1,346,548 | 59 | 918,701 | 41 | 2,285,249 | |
| 1906 | 2,119,764 | 76 | 665,845 | 24 | 2,785,609 | |
| 1907 | 2,436,093 | 78 | 672,630 | 22 | 3,108,723 | |
| 1908 | 2,665,289 | 85 | 469,049 | 15 | 3,134,338 | |
| 1909 | 4,010,180 | 97 | 142,194 | 3 | 4,152,374 | |

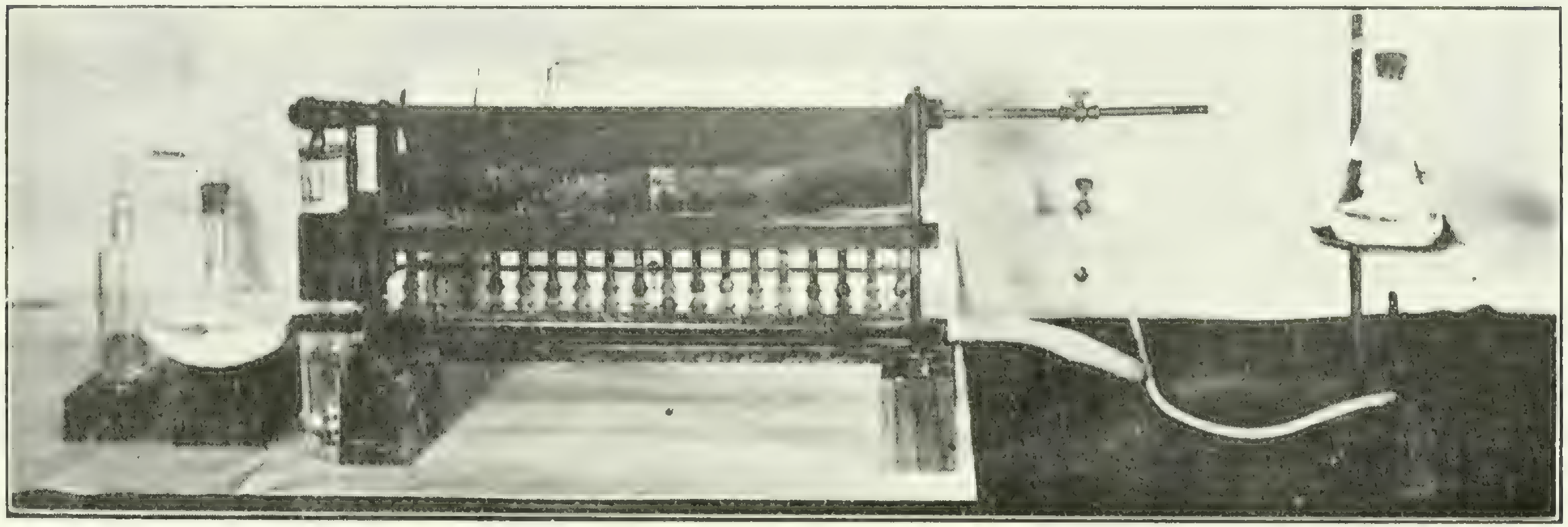
## Exports of the Product of the Mine, Year 1909.

(Compiled from Trade and Navigation Monthly Statements.)

| Products. | | Quantity. | Value. |
|---|---|---|---|
| | | | $ |
| Arsenic | Lbs. | 3,111,249 | 119,673 |
| Asbestos | Tons. | 56,971 | 1,729,857 |
| Chromite | " | 1,794 | 20,858 |
| Coal | " | 1,588,099 | 4,456,342 |
| Feldspar | " | 10,834 | 35,234 |
| Gold | | | 5,629,551 |
| Gypsum | Tons. | 315,201 | 372,286 |
| Copper, fine in ore, etc | Lbs. | 54,447,750 | 5,832,246 |
| Lead, in ore, etc | " | 6,226,068 | 132,578 |
| " pig, etc | " | 11,301,960 | 361,064 |
| Nickel, in ore, etc | " | 25,616,398 | 2,676,483 |
| Silver, in ore, etc | Ozs. | 31,126,504 | 15,719,909 |
| Platinum, in ore concentrates, etc | " | 466 | 2,118 |
| Mica | Lbs. | 717,066 | 256,834 |
| Mineral pigments | " | 1,316,514 | 7,956 |
| Mineral water | Gals. | 60,562 | 7,433 |
| Oil, refined | " | 7,768 | 934 |
| Ores | | | |
| Antimony | Tons. | 4 | 120 |
| Iron | " | 21,956 | 61,954 |
| Manganese | " | 3 | 434 |
| Other ores | " | 17,939 | 625,142 |
| Phosphate | " | 895 | 15,735 |
| Plumbago | Cwt. | 20,070 | 52,440 |
| Pyrites | Tons. | 35,798 | 156,644 |
| Salt | Lbs. | 276,765 | 2,488 |
| Sand and gravel | Tons. | 481,584 | 256,166 |
| Slate | " | 134 | 612 |
| Stone, ornamental | " | 1,027 | 8,606 |
| " building, etc | " | 26,672 | 15,481 |
| " for manufacture of grindstones | " | 125 | 1,685 |
| Other products of the mine | | | 109,350 |
| Manufactures— | | | |
| Bricks | M. | 365 | 2,255 |
| Aluminium, in bars, etc | Cwt. | 61,345 | 918,195 |
| " manufactures, etc | | | 3,453 |
| Cement | | | 113,362 |
| Clay, manufactures of | | | 979 |
| Coke | Tons. | 74,067 | 329,051 |
| Grindstones, manufactured | | | 13,942 |
| Gypsum, ground | | | 2,787 |
| Iron and steel— | | | |
| Stoves | No. | 744 | 10,330 |
| Castings, N.E.S | | | 25,038 |
| Pig iron | Tons. | 5,063 | 186,978 |
| Machinery (linotype machines) | | | 43,686 |
| Machinery, N.E.S | | | 421,707 |
| Sewing machines | No. | 12,759 | 147,402 |
| Typewriters | " | 3,749 | 238,167 |
| Scrap iron and steel | Cwt. | 410,506 | 305,256 |
| Hardware, tools, etc | | | 52,207 |
| " N.E.S | | | 35,507 |
| Steel and manufactures of | | | 1,132,678 |
| Lime | | | 48,821 |
| Metals, N.O.P | | | 134,062 |
| Plumbago, manufactures of | | | 864 |
| Stone, ornamental | | | 33,097 |
| " building | | | 501 |




Apparatus for the determination of crude oil.



Apparatus for the Determination of Ammonium Sulphate.

## APPENDIX II.

# DESCRIPTION OF COMMERCIAL METHODS AND APPARATUS FOR THE ANALYSIS OF OIL-SHALES

BY

**Harold Leverin, Ch.E.**

The commercial value of oil-shales depends chiefly on the amount of crude oil and ammonium sulphate—per ton of shale—obtainable therefrom. With a view to providing for the accurate determination of the amount of these products in Canadian oil-shales, methods have been adopted which have been carefully checked, and are found to be in accord with the latest, improved, manufacturing methods. The following is a brief description of the methods adopted and apparatus installed in the chemical laboratory of the Mines Branch, Department of Mines, Ottawa, for the distillation, etc., of oil-shales.

### DETERMINATION OF CRUDE OIL.

Hitherto, the nature of the carbonaceous matter in oil-shale has not been determined; but it can be affirmed with certainty that, it does not exist in the shale in the same condition as the substances obtained by destructive distillation of the shale; since none of these substances can be extracted by solvents, such as petrolic ether, benzine, etc.; but are formed by destructive distillation.

The apparatus for this determination (Plate I) consists of a malleable iron tube, $2\frac{1}{2}''$ inside diameter $\times$ $36''$ long, closed at one end with an iron cap, and at the other by a disc B, secured by means of a clamp A, and packed with a lead washer in order to seal the retort perfectly. The retort is inclined at a convenient angle to enable the oil to run off. The oils, in both gaseous and liquid state, pass through tubes C and D; the oils already condensed being collected in the copper receptacle E. The others pass through condenser F into flask G, which is connected to flask H. Both the flasks are immersed in ice water. Generally, two-thirds of the distilled oils are received in receptacle E; the remainder in flask G; except a few drops, occasionally, in flask H. The retort is heated in a gas tube furnace of the American Gas Furnace Company's make.

The process of destructive distillation (Plate II) is comparatively simple. One pound of shale crushed into pieces $\frac{1}{2}''$ square is placed in the retort, and heated gradually to a dull red heat, great care being exercised not to raise the temperature too suddenly, or higher than a dull red heat, otherwise considerable losses will occur. At lower temperatures the hydrocarbons of the fatty series are evolved; but at higher, those of the aromatic. When the temperature is too high, a white smoke is readily noticed in the glass flask; so that it is comparatively easy to keep the right temperature in the retort. The time generally required for distillation is $2\frac{1}{2}$ hours, after which the oil obtained is cooled, separated from water, measured, and its specific gravity determined.

When the chemist has not at his disposal the apparatus described above, the following simple, and cheaper arrangement may be used instead:—

The tube used is made of a ⅛ inch wrought-iron tubing, 2″ inside diameter × 6′-0″ long. The tube is sealed at one end by an iron cap; the other end remaining open. No condenser is used; but the oil is collected as it runs out of the tube. The method of procedure is the same as already mentioned.

Although this method is used extensively in Scotch oil-shale works, and is suitable for most practical purposes, it is capable of giving only approximate results; as the lighter oils and naphtha are lost, and cannot be collected except by passing them through a condenser.

### DETERMINATION OF AMMONIUM SULPHATE.

The method of analysis adopted for the determination of ammonium sulphate obtainable from oil-shale is known as the Bailey method. This method has been checked against the manufacturing process in which the 'Pumpherston' retort is used, and gives like results; but as improvements are made in manufacturing, this method of analysis will have to be changed accordingly.

It seems a reasonable deduction that, a determination of the nitrogen present in oil-shale, and calculation of the equivalent ammonium sulphate, would give the possible amount of ammonium sulphate obtainable from the shale; but in manufacturing, considerable losses occur: a large part of the nitrogen is evolved as uncombined nitrogen; a smaller amount as cyanogen; while the balance remains in the spent shale. The 'Henderson' retort yielded 16 to 20 pounds of ammonium sulphate from a shale containing nitrogen—equivalent to 74 pounds of ammonium sulphate per ton of shale; the 'Young and Beilby' retort, twice as much; while the 'Pumpherston' retort gave a still greater return—calculated at 52 pounds. It is evident that the Bailey method can only be applied to the process in which the 'Pumpherston' retort is used.

The possibility of extracting nitrogen in the form of ammonium sulphate by the Bailey method was tested as follows:—

A sample of oil-shale from Taylorville, Westmorland county, N.B., was carefully analysed, the results being:—

| | |
|---|---|
| Volatile matter | 37·46 |
| Fixed carbon | 4·34 |
| Ash | 58·20 |
| Nitrogen | 1·21 |
| | 100·00 |

By destructive distillation, and by Bailey's method, the following values were found:—

| | |
|---|---|
| Crude oil | 45·00 Imperial gallons per ton (2,240 lbs.). |
| Specific gravity of oil | 0·905 |
| Ammonium sulphate | 89·3 lbs. |
| Nitrogen | 0·85 per cent. |

Nitrogen in the shale was determined by the Kjeldahl method, and the shale was found to contain 1·21 per cent of nitrogen—equivalent to 5·70 per cent, or 127·7 pounds of ammonium sulphate per ton of shale. The coke remaining in the tube was analysed by the same method, and showed 0·16 per cent of nitrogen—equivalent to 0·75 per cent, or 17 pounds of ammonium sulphate per ton of spent shale; which is a rather inconsiderable amount: only 0·10 per cent of nitrogen in the oil-shale; the spent shale containing 95·55 per cent of ash.

Thus, 70·2 per cent of the nitrogen in oil-shale can be obtained by the Bailey method, the loss being 29·8 per cent. Of this loss 8·2 parts remained in the spent shale; 21·6 parts being volatilized as uncombined nitrogen, and a smaller part as cyanogen.

*The Bailey Method:* 30 grammes of shale in small pieces are heated in a malleable iron tube, to bright redness, and subjected to a current of steam for one hour and a half; the resulting cases being led into a flask containing 2 N sulphuric acid. In this solution, ammonia is determined either by nitrometer or by redistilling with caustic soda.

The apparatus used consists of a malleable iron tube, ¾" inside diameter by 28" long; one end being closed by an iron cap—through which passes a brass tube; while the other end is connected with the steam supply. Pieces of previously ignited firebrick—about 5 millimetres in diameter—are dropped into the tube, so as to occupy about 8" of the tube next to the stop-cock. Then 30 grammes of shale—3 millimetres in diameter—are dropped into the tube, which is placed in the combustion furnace, with the portion containing the shale well in the centre of the furnace; so that it may readily be heated to a bright red. Into the open end of the tube next to the shale is fitted a cork, through which a brass delivery tube passes into a 600 c.c. flask, containing 50 c.c. of 2 N sulphuric acid. A second flask may be used to catch any ammonia that may be carried over. These flasks are immersed in ice water.

To start operations, the furnace is lighted, and the tube heated as rapidly as possible to bright redness: the time being noted when this is attained. It is essential that the time should not exceed 10 to 15 minutes. As soon as vapours begin to show in the glass tube, the stop-cock is opened and a moderate current of steam allowed to pass through the tube. The proportion of steam should be such that, after 1½ hours' heating to bright redness, about 400 c.c. of liquid are contained in the first flask. During operation the end of the iron tubes should be kept cold by wet lint or cloths wrapped around and kept moist in order to prevent charring the cork.

After 1½ hours, the apparatus is disconnected, care being taken that neither then nor at any time does any of the liquid go back into the tube, owing to reduction in pressure. The flasks are then rinsed out. To the liquid is added petrolic ether or other solvent for oil, thoroughly shaken, and the oil and liquid separated after standing for a few minutes. The liquid is made up to a volume of 500 c.c., or other convenient quantity, and then thoroughly mixed by shaking.

A measured portion of this liquid—say 250 c.c.—is evaporated in a porcelain dish on a water bath, until its volume is reduced to 5 or 6 cubic centimetres, and this residue is rinsed into the cup of a nitrometer, precaution being taken that all ammonia salts are transferred into the cup. Excess of sodium hypobromite is then added, the nitrometer is shaken, and the volume of nitrogen, temperature, and pressure is read off with all necessary corrections, from which data the total volume of nitrogen from 30 grammes of shale is calculated. One c.c. of nitrogen at N.T.P. is equivalent to 0·001562 grammes ammonia, from which the yield of ammonia sulphate per ton of shale may be readily calculated.

Sodium hypobromite is made by dissolving 5 c.c. bromine in 50 c.c. concentrated sodium hydrate solution. This solution is of such an unstable nature, however, that a fresh mixture has to be made for each determination.

Instead of using the nitrometer, a redistillation of the liquid with sodium hydrate may be made in the usual way; collecting the free ammonia in N sulphuric acid, and titrating the excess of acid with N alkali, using cochineal as indicator.

The assertion made by other chemists, that organic bases distil over with the ammonia, and hence render the resulting percentage of the latter too high, is not confirmed by the Mines Branch distillation tests; for this method was found to be quite accurate.

The following is a statement of Mines Branch analyses, compared with those made in the laboratory of the College of New York,[1] under the direction of Dr. Charles Baskerville:—

| Number. | Sample from: | (Hamor.) Nitrometer Method. Am. Sulp. per ton. | (Leverin.) Distilling Method. Am. Sulp. per ton. |
|---|---|---|---|
| | | Lbs. | Lbs. |
| 1 | Baizley's farm | 110 | 112·2 |
| 2 | E. Stephens | 67 | 70 |
| 3 | Adam's farm | 93 | 96 |
| 4 | Taylor's farm | 110 | 104 |

## Analyses of Oil-Shale.

(Leverin.)

| Number. | Locality. | Crude Oil. Imper. gal. per ton. | Specific Gravity of Oil. | Ammon. Sulp. lbs. per ton. |
|---|---|---|---|---|
| 1 | Baizley's farm, Baltimore, Albert co., N.B. | 52·0 | 0·904 | 112·2 |
| 2 | Stephens, Albert co., N.B. | 45·5 | 0·892 | 70·0 |
| 3 | Turtle creek, Albert co., N.B. | 56·8 | 0·891 | 30·5 |
| 4 | Stellarton, Pictou co., N.B. | 44·8 | 0·875 | 14·5 |
| 5 | Albert mine, quarry I, Albert co., N.B. | 22·2 | 0·892 | 28·0 |
| 6 | Albert mine, quarry II, Albert co., N.B. | 48·5 | 0·898 | 82·8 |
| 7 | Albert No. 2, Albert co., N.B. | 38·8 | 0·892 | 60·3 |
| 8 | " " 3, " " | 45·5 | 0·891 | 48·0 |
| 9 | " " 4, " " | 43·5 | 0·896 | 56·8 |
| 10 | " " 6, " " | 27 0 | 0·895 | 49·1 |
| 11 | Albert mine (Albertite), Albert co., N.B. | 112·0 | 0·857 | 93·5 |
| 12 | Tayloiville, Westmorland co., N.B. | 42·3 | 0·897 | 96·5 |
| 13 | " " " | 47·3 | 0·901 | 88·7 |
| 14 | " " " | 46·8 | 0·902 | 85·0 |
| 15 | " " " | 45·0 | 0·903 | 104·0 |

[1] See Mines Branch Report on Oil-Shales, by Dr. R. W. Ells. Part I, p. 17, 1909.

## APPENDIX III.

### COPY OF REPORT ON THE PREVENTION OF MINE EXPLOSIONS: PREPARED BY THREE FOREIGN EXPERTS FOR THE UNITED STATES GEOLOGICAL SURVEY, AND PUBLISHED OCTOBER 22, 1908.

*The report is addressed to the Secretary of the Interior, and with its recommendations is as follows:—*

PREVENTION OF MINE EXPLOSIONS.

*Foreign Experts make Report to Secretary of Interior.*

WASHINGTON, D.C., October 22, 1908.

(Special.)—The Geological Survey issues to-day a report on the prevention of mine explosions, submitted by three foreign experts, Victor Watteyne, inspector-general of mines, Belgium; Carl Meissner, councillor for mines, Germany; and Arthur Desborough, H. M. inspector of explosives, England. These engineers have been in the United States for six weeks, coming at the invitation of the United States Government to assist the Federal authorities in beginning the investigations authorized at the last session of Congress. The report was presented to Secretary Garfield, who transmitted it yesterday to President Roosevelt, stating that the report with its recommendations will be of the highest importance in aiding Congress and the different state governments in providing legislation to ensure more efficient and careful operation of coal mines, by the adoption of mining methods and safety appliances that will materially aid in preventing such terrible losses of life as have occurred through mine explosions in recent years.

In view of the fact that this report is the first result of the Geological Survey's scientific and practical study of the conditions under which more than half a million miners work, the President ordered its immediate publication and distribution among the coal-mine operators and miners of the country. The report is addressed to the Secretary of the Interior, and with its recommendation is as follows:—

### REPORT.

In response to your request that we co-operate with the United States Geological Survey in the inauguration of its investigations looking to the prevention of mine explosions, and that we submit for the consideration of those connected with the coal-mining industry in the United States such recommendations as experience in our own countries and observations among American coal mines indicates may be useful in providing for greater safety, we beg to submit the recommendations given below.

Since coming to the United States, we have given careful attention to and approve the investigations in relation to this subject begun by the Geological Survey. We have visited typical mines in the more important coal fields of the United States, and have discussed the mining problems with many coal operators, miners, and state inspectors.

To be effective, investigations for the benefit of mining must be continuous. The opening up of new mines, the deepening of old mines, the meeting with new condi-

tions, the changing of explosives, and the inauguration of new processes and methods will call for continuous investigations, to be followed by continuous educational work.

Our investigations and recommendations relate primarily to questions of safety in mining; but in this connection we have been greatly impressed with another closely associated phase of the industry, viz., the large and permanent loss of coal in mining operations in many portions of the United States. This is a serious, permanent, and national loss. It seems to be a natural outcome of the ease with which coal has been mined in the United States and the enormously rapid growth of the industry.

The active competition among the operators, and the constant resulting effort to produce cheaper coal, has often naturally led to the mining of only that part of the coal which could be brought to the surface most easily and cheaply, leaving underground, in such condition as to be permanently lost, a considerable percentage of the total possible product. Certainly much of this loss can be prevented through the introduction of more efficient mining methods, such as the long-wall system, more or less modified, the flushing method. (*See* 'H' 7.)

In the preparation of these recommendations we have recognized fully the great differences between the mining conditions in Europe and those in America, where the industry has developed so rapidly that thorough organization has not yet been possible; where a large percentage of the men entering the mine are unfamiliar either with mining methods or the English language; and where the price of coal at the mine is less than half that in Europe. Nevertheless, we believe that these recommendations will be found useful in the further development of the American coal-mining industry for safety and efficiency. The cordial reception everywhere accorded us leads us to believe that these recommendations will be received by the operators and miners in the same spirit of good will as that in which they have been prepared. But the success of this movement for greater safety and efficiency will depend upon the hearty and patient co-operation of the operators and the miners, working together for the accomplishment of this purpose.

## RECOMMENDATIONS.

### *A.—Selecting the Explosives to be used.*

(1) We recommend that the Government of the United States examine the explosives now and hereafter used in mining, with a view to eliminating the more dangerous explosives and to improving and standardizing such explosives as may be considered most suitable for such use, these to be designated by the government 'permissible explosives.'

The term 'permissible explosives' is suggested for the reason that no explosives are entirely safe, and all of them develop flame when ignited; and we advise therefore against the use in the United States of the terms 'safety explosives' or 'flameless explosives,' as these terms may be misunderstood and this misunderstanding may endanger life.

(2) We recommend that the operators and miners of coal use only such explosives as are included in a list of 'permissible explosives,' when the same has been published by the Government, in all mines where there is risk of igniting either dust or gas, selecting that one which their own experience indicates can be used to the best advantage under local conditions.

(3) We also recommend that investigations be conducted to determine the amount of charge of such 'permissible explosives' which may be used to the best advantage under different conditions with a view to reducing danger to the minimum.

*B.—Carrying the Explosives into the Mines.*

(1) All explosives should be made into cartridges and placed in closed receptacles before being carried into the mine, and the quantity carried into the mine during one day by any miner should be limited as nearly as practicable to the quantity needed by him for use during that day. Handling loose explosives and making them into cartridges by an open light in the mine should be prevented.

(2) Detonators or caps should be handled with great care, and should be carried only by a limited number of responsible persons.

*C.—Use of Explosives in the Mine.*

(1) Shooting in or off the solid should not be practiced.

(2) The depth of the shot hole should be less by at least 6 inches than the depth of the cutting or mining. The use of very deep shot holes should be avoided as unnecessarily dangerous.

(3) The overcharging of shots (the use of a larger charge than is required to do the work satisfactorily) should also be avoided as unnecessary and dangerous. The proper standardization of explosives used in coal mining will greatly facilitate the carrying out of this recommendation. (*See* also 'A' 1.)

(4) Shots should never be tamped with fine coal or material containing coal. Clay or other suitable material should be supplied and used for this purpose.

(5) The firing of two or more shots in one working place, except simultaneously by electricity, should not be allowed until a sufficient interval has elapsed between the firings to permit an examination of the working place, in order to see whether any cause of danger has arisen.

(6) Before a shot is fired the fine coal should be removed from the working place, as far as practicable, and the coal dust on the floor, sides, and roof, for a distance of at least 20 yards from the place where the shot is to be fired, should be thoroughly wet, unless it has been demonstrated that the dust in the mine is not inflammable. (*See* also 'E' 1.)

(7) If gas is known to occur in the mine, no shot should be fired until, in addition to the watering, an examination made immediately preceding the time for firing, by a competent person, using a lamp which will easily detect 2 per cent of gas, has shown the absence of that amount of gas from all spaces within 20 yards of the point where the shot is to be fired.

(8) Believing that such will be one of the greatest advances which can be made in safeguarding the lives of the miners, we recommend the adoption of a system of electric shot firing, in all mines where practicable, by which all shots in the mine, or in each ventilation district of the mine, may be fired simultaneously, at a time when all miners and other employes are out of the mine.

*D.—Keeping the Mine Roadways clean.*

(1) The roadways of the mines should be kept as free as possible from loose coal which may be ground into dust and of rubbish in which such dust may accumulate, in order to facilitate the removal and wetting of the dust.

*E.—Wetting the Coal Dust.*

(1) In all coal mines where explosives are used it is desirable, and in all mines containing gas it is highly important, that the dust on the walls, timbers and floors of the working places and roadways should be kept continually wet prior to and during the work in the mine. If, however, conditions of roof or lack of water render

this general watering impracticable, at least the dust within twenty yards of each shot should be wet before each firing, and other precautions against explosions should be practiced with unusual care.

It is our opinion that a system of watering which occasionally sprinkles the floor only and leaves dry the dust on the walls and timbers of the roadways is useless, and is also dangerous, in that it may generate an unwarranted feeling of security against an explosion.

### *F.—Special Precautions for Mines Containing Gas.*

(1) In any mine where as much as 2 per cent of gas can be detected by suitable method, only locked safety lamps of an approved type should be used so long as such condition exists or is likely to recur.

All safety lamps should be maintained in good condition, cleaned, filled, kept in a special room at the surface, and carefully examined both when delivered to the miner and when returned by him at the close of each day's work. A defective safety lamp is especially dangerous because of the false feeling of security it engenders.

In the filling of lamps with benzine or other low-flash oils, which should always be done at the surface, special precautions against fire or explosions should be taken.

### *G.—Use of Electricity.*

(1) Electricity in mining operations offers so many advantages, and has been so generally adopted, that no reasonable objection can be made to its use under proper restrictions. The electrical equipment, however, should be installed, maintained, and operated with great care, and so safeguarded as to minimize danger from fire or shock. The fact that the effectiveness of some insulating materials is soon destroyed in most mines should not be lost sight of.

We recommend the following precautions: For distribution underground the voltage should not exceed 650 direct current or 500 alternating current, these voltages being intended for transmission to machinery operating at 500 volts direct current and 440 volts alternating current, respectively. Even lower voltages are preferable. The trolley wires should be installed in such manner as to render shocks least likely; that is, placed either high enough to be beyond easy reach or at one side of the track and properly protected.

Where current at a potential of more than 650 volts is employed for transmission underground, it should be transmitted by means of a completely insulated cable; and where a lead or armoured covering is used, such covering should be grounded.

In all mines having electric installation special precautions should be taken against the setting on fire of coal or timber. Enclosed fuses or cutouts are recommended, and each branch heading should be so arranged that the current may be cut off when necessary.

No live electric wire should be permitted in that part of any mine in which gas is found to the amount of 2 per cent.

In all mines producing gas in dangerous quantities, as indicated by a safety lamp which will detect 2 per cent of gas, the working places should be examined for gas by a qualified man, using such a lamp, immediately before any electric machine is taken or operated there.

### *H.—Precautions against Miscellaneous Accidents.*

(1) In all new construction, shaft lining and superstructures about the entrance of the shaft (or slopes or drifts) should be built as far as practicable of non-combustible materials.

About the entrances to mines every possible precaution should be taken to prevent fires or the injury of the equipment for ventilation and haulage. Ventilating fans should be placed at one side of the mine opening, and hinged doors or light timbering should render easy the escape of the explosive force in direct line of the shaft or slope.

Proper precautions should be taken for immediately preventing the entrance into the mine of heat and gases and for facilitating the escape of the men in case of surface or shaft fires.

(2) The surface equipment for handling the coal should be so arranged as to prevent coal dust from entering the mine shaft.

(3) In all new mines, and in all old mines as far as practicable, suitable main roads should be provided for the men separate from the main haulage roads.

(4) In connection with the system of ventilation it is recommended that in the more frequented roads connecting the intake with the return air courses, two doors be provided, these doors to be placed at such a distance apart that while one is open the other is closed.

(5) In view of the large number of accidents from falls of coal or roof, under the existing practice with single props, more attention should be given to the introduction in mines where the roof is bad of better systems of timbering, such as have been long in use with economy and safety in many well managed mines.

(6) In undercutting coal by hand, the premature fall of the coal should be prevented by sprags or other suitable supports.

(7) We believe that the difficulties and dangers encountered in the working of coal seams which are thick and steeply pitching, or of which the coal is highly inflammable in character or subject to firing from spontaneous combustion, and in mines where the subsidence of the surface must be avoided, may be successfully and economically overcome in many cases through the adoption of the flushing system of mining—that is, the filling with sand or other similar materials of the space from which the coal is removed. This system originated in the United States and is now successfully practiced in portions of Germany, Austria, Belgium, and France.

### *I.—Mine Supervision and Inspection.*

(1) We cannot too strongly emphasize the fact that thorough descipline about the mine is absolutely essential to safety, and that thorough descipline can be brought about only through the hearty co-operation of the operators, the miners, and the State.

(2) We are of the opinion that the reponsibility for safety in the mine should primarily rest with some person, such as the manager or superintendent, clothed with full authority; and that such person can greatly facilitate the attainment of safety through the employment of a sufficient number of foremen, and also of one or more inspectors whose special duty it shall be to see that the regulations are strictly enforced.

(3) The State cannot exercise too much care concerning the experience, technical training, and selection of its inspectors. Their positions should be made independent of all considerations other than that of efficiency; and their continuance in the service should be co-existent with good behaviour and proper discharge of official duty.

### *J.—Training for Mine Firemen, Inspectors, etc.*

We are of the opinion that the cause of both safety and efficiency in coal-mining in the United States would be greatly aided through the establishment and maintenance in the different coal regions of special schools for the training of fire bosses,

mine foreman, superintendents, and inspectors. The instruction in such schools should be practical rather than theoretical.

The work of these schools would supplement most effectively that of the colleges already established in many parts of the country for the more thorough training of mining engineers.

# APPENDIX IV.

## ON THE EXAMINATION OF MAGNETIC ORE DEPOSITS.

*Howells Fréchette, M. Sc.*

In the examination of magnetic ore deposits much useful information may be gained by an investigation of the strength and direction of the magnetic force exerted by the ore at various points in its neighbourhood.

These ore bodies may be considered as huge magnets penetrating the earth's surface, having all the properties of magnets as we know them. In the northern hemisphere the upper portion of the ore body is of north polarity and the lower portion is of south polarity. This arrangement is due to the magnetism being induced by the magnetic lines of force of the earth.

The following is a brief statement of the method of observation used by the Mines Branch of the Department of Mines, and the method of interpretation, leaving aside the more technical calculations and the theory on which the methods are based.

The instrument employed to make the necessary magnetic measurements is the Thalen-Tiberg magnetometer. It consists of a compass mounted on a brass support in such a way as to permit the compass-box to rest either in a horizontal or a vertical plane. To the brass support is attached a horizontal arm about 10 inches long, having a movable carriage to which may be fixed a small magnet. The compass needle is pivoted so that it is free to swing when the box is either horizontal or vertical. The instrument is supplied with level bubbles, leveling screws, lining sights, adjusting screws, etc., and is mounted on a tripod.

### ADJUSTMENT OF THE MAGNETOMETER.

Although the magnetometer is tested and adjusted by the instrument maker before leaving his shop, it is advisable for the observer to satisfy himself as to the adjustments before using it. The necessary adjustments are fully described on page 29 in Dr. Eugene Haanel's book on the 'Location and Examination of Magnetic Ore Deposits by Magnetometric Measurements.'[1] There are, however, two adjustments given below which must invariably be made in the vicinity of the ore body, but not near enough to be within the reach of its magnetic influence.

The magnetometer is set up in a normal field, that is, at a point free from local magnetic disturbance. With the compass box horizontal, the instrument is rotated on its vertical axis until the needle points to 90°, that is, at right angles to the axis on which the compass box swings. The compass box is now tipped into the vertical plane. The needle should read zero, that is, it should swing into a horizontal position; if not, the small weight on the needle must be moved along until the needle registers zero. The weight is then clamped.

The compass box is again tipped into the horizontal plane and the needle swings back to 90°. The needle is now at right angles to the arm of the brass support. The small deflecting magnet is then placed on the carriage of the arm, parallel to the arm. This causes the needle to swing away from its original position. The carriage is now moved along the arm until the needle reads, say 60° on the scale, and then clamped. In other words, with the present setting of the deflecting magnet, the

---

1 Issued by the Mines Branch, Department of Mines.

deflextion of the needle is 30°. Certain conditions may demand a different setting of the magnet, which, of course, would change the amount of deflexion when set up in a normal field, but 30° is found in most cases to be satisfactory.

After thus preparing the instrument, it is ready to be used for the measurement of the vertical and horizontal intensity of the magnetism in a disturbed field, that is, where the influence of the magnetic ore body is felt.

The lines of force of the magnetic ore body radiate in all directions, therefore, for convenience of observation and calculations, the force at any point is resolved into two component forces at right angles to each other, the vertical force and the horizontal force.

The magnetometer is set over the point of observation with the compass box horizontal, the needle brought to 90° by rotating the instrument on its vertical axis. The instrument is then clamped, the compass box tipped into the vertical plane, and the needle read. Should the north seeking end of the needle point down, we have a reading of positive vertical intensity; if up, a reading of negative vertical intensity, which is recorded by prefixing the minus sign.

The compass box is tipped back to the horizontal position, and the needle again reads 90°. The deflecting magnet is now placed on the carriage and the needle read. The deflected angle is noted. Care must be taken not to have any magnetic substances near the instrument that would affect the readings.

## EXAMINATION OF A MAGNETIC ORE DEPOSIT.

The area of ground under examination should first be gone over thoroughly with some form of dip needle and the points of maximum dip marked. The Swedish Mining Compass is the best instrument for this purpose as the needle of it is so suspended that it is free to range itself along the local magnetic meridian, and also free to dip. A line joining the points of greatest dip gives the general direction of the strike of the ore field.

A base-line is now run through one of these points, parallel to the strike, stakes being driven at regular intervals, 30 feet for convenience. From these stakes, and at right angles to the base-line, subsidiary lines are run to the limit of the disturbed field. These lines are also staked every 30 feet. In this manner the whole area to be investigated is laid out in squares.

For the purpose of identifying any stake in the field, the rows of stakes parallel to the base-line are marked with letters, those at right angles to it with numerals; thus on each stake is marked the letter and number of the respective rows to which it belongs.

Readings of the vertical and horizontal intensity should be taken at each stake.

## MAPS.

If the vertical and horizontal intensities have both been determined, it will be necessary to make two maps.

Where the interval between stakes has been made 30 feet, it will be convenient to plot our maps on the scale of 60 feet to one inch. The paper is cross-ruled at ½″ intervals, thus representing the lines laid out on the ground.

### *Map of Vertical Intensity.*

The vertical intensity of each stake, as represented by the degrees read on the compass scale when in the vertical plane, is marked at the intersection of the corresponding lines of the map. When all the readings have been marked on the map, lines, known as the isodynamic lines, are drawn through points of equal intensity. The method of drawing these lines is similar to that used in drawing con-

tours of elevation. They are drawn at intervals of 10°, through the zero points and through every 10th degree higher and lower than zero. It is usual to colour the map; the positive areas blue and the negative areas yellow. Between 0° and 10°, and 0° and — 10°, one wash is used, between 10° and 20° and — 10° and — 20° two washes, and so on, thus giving deeper shades for the high positive and high negative areas.

### *Map of Horizontal Intensity.*

A map of the horizontal intensity is prepared in a similar manner. In this case, however, the isodynamic lines are drawn at intervals of 5° instead of 10°. Having taken 30° as our deflexion angle in a normal field, we must adopt 30° as our neutral line. Areas of intensity above 30° are coloured green, and below 30° pink. Thus we have the areas between 30° and 35° with one wash of green, between 35° and 40° two washes of green, between 30° and 25° one wash of pink, between 25° and 20° two washes of pink, and so on.

Besides the magnetometric readings, the maps should show outcrops, ore and rock piles, shafts, pits, buildings, roads, streams, etc.

## INTERPRETATION OF MAGNETOMETRIC MAPS.

### *Map of Vertical Intensity.*

In interpreting our maps, we must recognize the fact that the contour of the ground over which the observations were made has a marked effect on the shape of the isodynamic curves; therefore, let us first consider the ideal case, that in which the land is perfectly level.

From the map of vertical intensity we gain the most information. In general, the highest positive readings of vertical intensity are found to be over the upper pole of the ore body. Long narrow curves of somewhat regular, elliptical shape indicate an ore body regular in form.

The strike of the ore body is along the direction of the longest axis of the curves of maximum intensity. Irregularities in these curves are occasioned by irregularities of the ore mass, by neighbouring ore bodies, or by the presence of some distributing magnetic influence, such as from an ore pile, rock pile containing ore, or from iron or steel in structures or machinery.

The dip of the ore body is indicated by the relative spacing of the curves on either side of the area of maximum intensity. If the distances between the curves are greater on one side than on the other, the body dips towards the side where the curves are nearest together, that is where the magnetic intensity decreases most rapidly.

The action of the lower pole of the ore body comes into evidence in the production of a negative area, which occurs with every magnetic ore deposit and which surrounds the area of positive intensity. If the ore body extends vertically to a great depth, the attraction of the lower pole is correspondingly feeble, but increases in intensity as the dip of the ore body decreases and the lower pole approaches the surface.

In determining the size and shape of the ore body, very close attention must be paid to all outcrops of the ore and their positions compared to the isodynamic curves. The higher curves of positive intensity will generally represent the approximate shape of the ore body.

The above applies to distinct bodies of ore not having great thickness of cover over them, but should the ore body be deeply covered we can determine its position but cannot arrive at any close conclusions regarding its size or shape. The maximum intensity in this case will, of course, be much lower than where the ore reaches to the surface.

Where we have to deal with an uneven low grade, or disseminated ore each case becomes a special problem to be worked out by careful reasoning and comparison with somewhat similar occurrences.

So far we have only considered deposits situated where the ground is level. This is seldom met with in practice, therefore we must note the effect of taking our observations at different altitudes, such as would be done where we have cliffs or hilly ground. We will consider an extreme case. Suppose a body outcrops at or near the top of a cliff. We will get a strong positive reading at the top of the cliff, and at the foot a strong negative. In both cases it is the upper or north pole of the ore body that exerts the greatest influence on the magnetometer needle. In the first instance the pole is below the level of the instrument, and will draw the north-seeking end of the needle down, giving the positive reading; in the second the pole is above the level of the instrument, drawing the north-seeking end up, giving the negative reading.

Readings taken down a hill side on which the ore outcrops, will decrease more rapidly than would readings taken at corresponding distances from the same ore body, were the terrane level.

It is important to keep these facts in mind when interpreting magnetometric maps, therefore notes as to the slope of the ground should be made, or better, a contour map of the ground prepared on the same scale on tracing paper to be laid over the magnetometric map. The contours might be plotted on the same map, but this would probably cause a confusion of lines.

### *Map of Horizontal Intensity.*

From this map we learn little else than the location of the upper pole of the ore body.

Where we are dealing with a single ore body of regular form, if we draw a line through the maximum point and the minimum point of horizontal intensity the point of intersection of this line with the neutral line indicates the position of the upper pole of the ore body. If, however, we are dealing with a group of ore bodies or a body of irregular shape, the map becomes complex and definite information cannot be obtained from it.

#### DEPTH BELOW SURFACE, ETC.

Should the ore body not outcrop we may determine the thickness of covering over it. We can, also, where conditions are favourable, determine the depth to which the body extends.

The methods involved in determining these quantities are somewhat complex and do not come within the scope of this article. For these methods reference must be made to Dr. Haanel's book, already referred to, which is the only exhaustive treatise on the subject in English.

It is to this volume that I am indebted for the information conveyed in this article.

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# DEPARTMENT OF MINES
## MINES BRANCH

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